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PLANT OF THE COMMONWEALTH POWER COMPANY

FURNISHING ELECTRIC POWER AND STEAM HEAT IN MILWAUKEE

BY T. S. WATSON

THE Commonwealth Power Co. of Milwaukee is a corporation operating under the public service laws of the state of Wisconsin. But, unlike most such companies, this was the outgrowth of the necessity for simpler, more efficient, power arrangements of several allied interests. The most important of these are the Jos. Schlitz Brewing Co. and the Continental Realty Co., the latter a large owner of business property in the heart of Milwaukee. Inasmuch as the companies concerned use a great deal of power and with but little increase in expenditure, the plant could be made of sufficient capacity to provide for a large

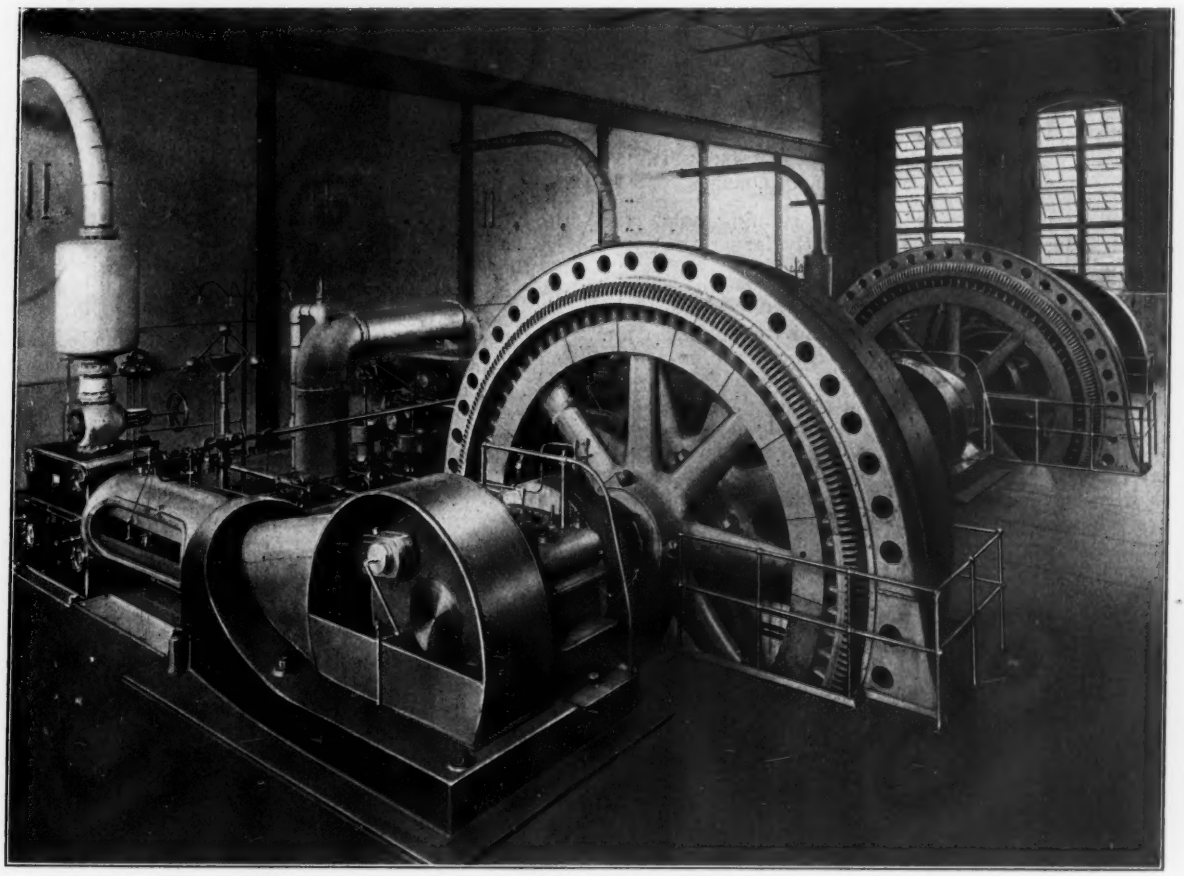


FIG. 1. ENGINE ROOM OF THE COMMONWEALTH POWER CO. OF MILWAUKEE; 2 1000-KW. AND 1 500-KW. ALLIS-CHALMERS ALTERNATING-CURRENT GENERATORS AND HEAVY DUTY CROSS-COMPOUND ENGINES

amount of outside commercial service. The generating station here described was built and has now been in successful operation for more than a year.

Location and Building

The plant is located about 1.5 miles from the main business center of the city on the west bank of the Milwaukee River near the Holton Street viaduct. This location makes it possible to receive coal by water, which admits of the lowest possible freight rates, and also enables water to be taken directly from the river for boiler feed and condensing purposes.

Concrete foundation for the building is supported on piling as the earth is very unstable close to the river. The superstructure of the building is of brick. The roof is of tile and concrete, nearly flat and is supported by structural steel trusses. The building is about 110 ft. square and is divided into boiler and engine room by a brick fire wall running north and south. The engine room is slightly larger than that containing the boilers.

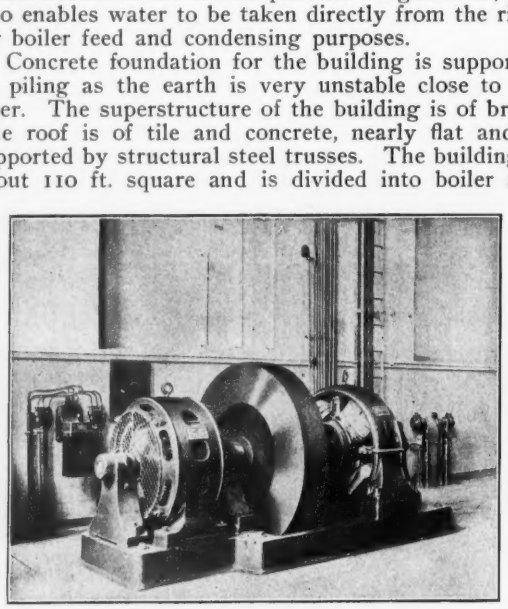


FIG. 2. FLYWHEEL MOTOR-GENERATOR SET FOR SUPPLYING CURRENT TO ELECTRIC COAL UNLOADERS

Coal Handling

Coal is delivered to the plant in barges which come from the lower lakes. As of course no boats can come during the winter season ample storage for the winter's supply has to be provided, and a space approximately 100 by 500 ft., having a capacity of about 40,000 tons, and owned by an allied interest, is reserved for this just north of the viaduct. Two electrically equipped, man trolley, Johnson coal bridges are provided for unloading the barges. These receive their electrical supply from a motor generator, to be described later, and have the 2.5-ton grab bucket balanced.

In delivering the coal from the piles to the boiler room the same traveling bridges and buckets are employed, delivering the coal, which is run of mine, to hoppers which were built on the bridges and which have screens made of grizzly bars set at an angle of approximately 45 deg. The coal which does not pass the screen is carted away in wagons and used in other steam plants. That which does pass the screen is delivered to a 20-in. electrically driven Robins belt conveyor extending under the run of the bridges, which carries it to the end of the boiler house as shown in the photograph, where it is dumped into a bucket conveyor.

This conveyor, which is motor driven, encircles the boiler house and disposes of the coal in the 4 40-ton hoppers, 1 for each boiler, which are located above and in front of the boilers. This same bucket conveyor takes the ash from the pits beneath each furnace and delivers them to a fifth bunker from which they can be discharged either to wagons or to barges in the river. Each of the boiler hoppers is provided with an Avery automatic scale so that accurate records of the coal consumption can be maintained.

Steam Supply

Steam generating equipment consists of 4 500-hp. Edge Moor boilers having 5000 sq. ft. of heating surface each, which are provided with mechanical stokers. The boilers and furnaces are built in a novel manner which seems to have many advantages over the ordinary brick setting. The furnace proper is built with brick walls in the usual manner but in addition has a brick roof over the entire combustion chamber, which means the boiler does not come in direct contact with the flame of the fire but only with the hot gases, which make 3 passes through the tubes. The boiler itself is enclosed in walls of asbestos 2.5 in. thick, the object of these being twofold; first to prevent infiltration of air and second to keep the radiation losses as small as possible.

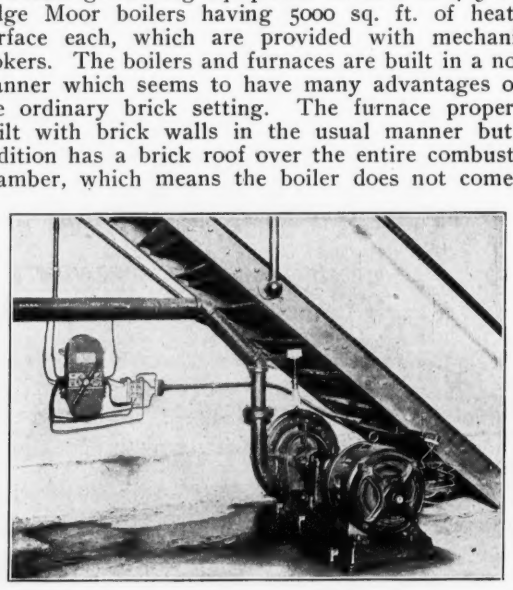


FIG. 3. INDUCTION MOTOR-DRIVEN CENTRIFUGAL PUMP FOR SUPPLYING BOILER FEED WATER

Each boiler is provided with an independent self-supporting steel stack 66 in. outside diameter and 145 ft. high, lined for half its height with 4 in. of vitribestos. Foster superheaters give a superheat of about 90 deg.

Boiler feed water is obtained from the condenser hot well and is delivered to the heater by a motor-driven centrifugal pump, through duplicate cross connected lines of 5-in. pipe which connect the hot well and the heater and boilers.

The Dodge heater used is of rather peculiar construction and acts both as an open and closed heater and filter. Water from the hot well enters the heater and receives heat from the exhaust steam of the auxiliaries and then passes downward through a sand filter from which it goes to the feed pumps; these force it back through a second filter in the heater in which the water passes upward and then to the boiler. This method of treatment seems to be satisfactory for the river water, as little trouble has been experienced with deposits in the boilers. Two outside packed 12 and 6 by 12 in. plunger feed pumps are used. The piping arrangements are such that, if necessary, water can be taken from the city mains or the river.

Steam is taken from each boiler by bends of 6-in. pipe which connect to a 12-in. welded steel header which runs in the rear of the boilers. In the loop is

placed a Davis stop and check valve and an angle valve is used where each bend enters the header. Steam for the main units is delivered at a pressure of 165 lb. while the auxiliary machinery receives steam at 125 lb. pressure from an auxiliary steam loop in which the pressure is reduced. Steam is delivered to the generating units through bends connected to the top of the steel header and having an angle valve at the header. Crane separators are placed on each line.

In the boiler room is also located the dry air pump for the condenser, of the rotative crank and flywheel type made by the Union Steam Pump Co.

Generating Current

The engine room contains 2 1000-kw., and 1 500-kw. generating units, a steam driven exciter set, a motor-generator exciter set, a motor generator set

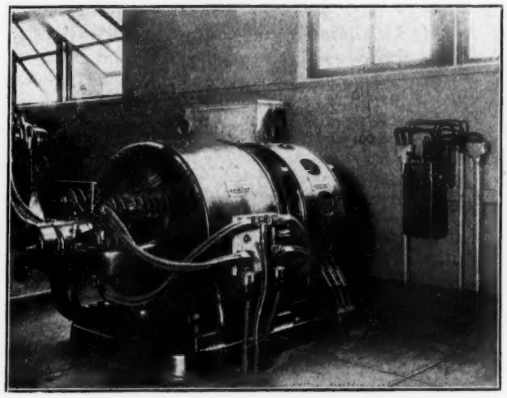


FIG. 4. MOTOR-GENERATOR EXCITER SET AND STARTER

for furnishing current to the coal unloaders, switchboard, oil pumps, etc. It is spanned by a 25-ton electric crane arranged to be operated from the floor.

Two 1000-kw. generating units are of the revolving field type and have 72 poles. When making 100 r.p.m. they deliver 3-phase, 60 cycle current at 2300 volts. These units are direct connected to 24 and 50 by 48-in. heavy duty cross-compound Corliss engines which operate under a steam pressure of 165 lb. and 26-in. vacuum, referred to a 30-in. mercury column. The steam has about 70 deg. of superheat at the throttle. A flywheel 18 ft. in diameter and made very heavy gives extremely close regulation.

The third main generating unit has a capacity of 500-kw. when turning 120 r.p.m., and except for size and capacity it is the same as the larger unit. It is driven by a 20 and 40 by 36-in. heavy duty cross-compound Corliss engine which operates under the same conditions as the larger engines.

All the main journals are of the 4-piece type with wedge adjustment. The engines are provided with the standard-eccentrics, long-range cutoff Corliss valve gear usually furnished by the builders of the engine. The selection of these sizes of units makes the installation very pliable so that it will operate at highest efficiency at all loads.

Exhaust Steam Disposition

Exhaust from all the engines discharges into a common exhaust main of cast-iron pipe which enlarges through its length from 24 in. to 36 in. where it connects to the riser leading to the 48-in. 2500-kw. Tomlinson Type B barometric condenser located just outside the building. The exhaust piping from each engine is fitted with special valves which effectively prevent any air leakage to the exhaust line when the engine is not in operation.

Injection water for the condensers is taken from the river by duplicate 12-in. double suction single stage, centrifugal pumps driven by enclosed horizontal high-speed engines, either of which is sufficient for the work. The overflow from the hot well discharges to the river.

This arrangement of the central condenser plant gives the most direct flow for the exhaust steam and makes the handling of the condensing water the easiest possible. In this installation the exhaust pipe was carefully designed so that there is no perceptible loss in vacuum throughout its entire length, which is so common in central condenser plants.

A gravity oil system is used for supplying lubricating oil to all bearings, the oil being pumped from

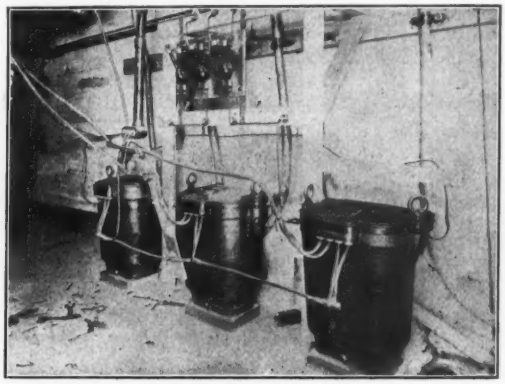


FIG. 5. LIGHTING TRANSFORMER INSTALLATION SUPPLIED BY ALLIS-CHALMERS CO.

a receiving tank in the basement to a storage tank and filter supported above the engine room in the roof trusses. An average head of about 25 ft. is maintained.

Exciters and Motor-Generators

Excitation of the generators is usually obtained from a 65-kw. induction motor-generator set which delivers direct current at 120 volts. The motor receives current at 220 volts, 3-phase and 60 cycles and runs 850 r.p.m. For furnishing exciting current when starting up the machine, a 120-volt, direct-current machine, direct connected to a high-speed, steam engine, is installed.

Of particular interest is the installation of a four-bearing flywheel, motor-generator set which furnishes current to the coal hoist. The motor is of the ordinary squirrel cage type designed for 110 hp. capacity and to operate under a pressure of 2200 volts, on 60-cycle, 3-phase current. The direct generator of the set is of special interpole design and rated at 75 kw. Its average load is about 60 kw., but it is guaranteed to carry 200 kw. for 1 min. without injurious flashing or burning. It has carried instantaneous load of as high as 240 kw. This has been made possible by the use of a machined solid steel flywheel weighing 7500 lb. which retains sufficient stored energy to carry the short time peak loads.

Electrical Distribution

The switchboard is made of dark mottled marble with beveled edges and has 11 panels. There are 2 exciter panels, 1 for the motor generator and 1 for the engine-driven unit; 2 direct-current and 1 alter-

nating-current panels for the various motors; 3 generator panels and 3 feeder panels. Wagner indicating and Westinghouse recording instruments are used on the switchboard while General Electric oil switches with remote, mechanically-operated, control are used for high-tension service. A Tirrell regulator is also installed.

An electrically driven air compressor, of the same character as used on street-cars, is installed in the basement for supplying compressed air for cleaning the electrical apparatus and blowing the boiler tubes.

Two cables, either one large enough to carry the full output of the generating station, lead to the main substation at the Jos. Schlitz Brewing Co.'s plant through conduits. From this point power is distributed to other substations about the brewing establishment and to 3 stations in the business section located in the Alhambra, Majestic and Kopmier Buildings.

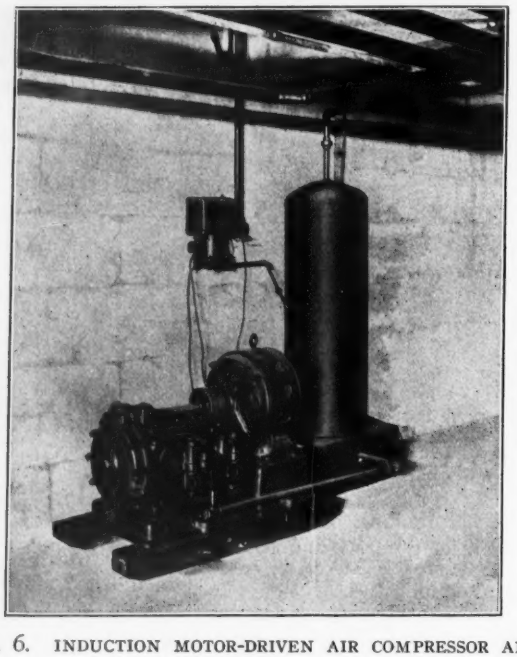


FIG. 6. INDUCTION MOTOR-DRIVEN AIR COMPRESSOR AND TANK

Substations

Of these substations the largest is located in the basement of the Alhambra Building. This consists of 1 200 and 1 300-kw. synchronous and 1 55-kw. induction motor generators. The induction set is used to supply current at light loads and also for starting the synchronous sets on the direct-current side. Direct current at 120 volts is supplied by the 3-wire system. At the Alhambra substation is also located a low-pressure boiler plant for supplying steam heat.

The Majestic building substation nearly opposite the Alhambra contains no motor-generator sets but receives direct current from the Alhambra station by wires carried in a tunnel connecting the 2 buildings, which also carries steam heating mains. The alternating-current bus bars in the 2 theatre substations are tied together by a cable running in the tunnel so that, if the feeder line from the brewery substation to either of the others is disabled, there will be no interruption to service.

For general power and lighting purposes, distribution is by means of a 3-phase 4-wire system which gives alternating current at 220 or 128 volts. Three-phase motors are used for all power purposes. The new Auditorium is one of the largest lighting customers of the company.

In the operating load of the power plant almost ideal conditions exist. The brewery takes a large amount of day load from 8 o'clock to 5 and some night load. There is also a continuous day load from other consumers.

In the evening a lighting load comes on which practically replaces the day load. These various demands for power give the station a load factor of practically 50 per cent.

Under these conditions the station has been operated under the best of loads and a remarkable plant economy has been shown. With an average 24-hr. load of about 12,000 kw. the average coal consumption for a month has been 3.5 lb. per kw-hr. and it is expected that this will be improved upon.

Wm. B. Uehlein is chief superintending engineer of the Commonwealth Power Co. The Power Improvement Co., of Milwaukee, acted as consulting engineers, while Allis-Chalmers Co. furnished all engines and electrical apparatus together with necessary auxiliaries.

WESTERN POWER INSTALLATIONS

An idea of the power development in the West is gained from some figures given in the 1910 edition of Blanchfield's Western Electrical & Gas Directory. In one city alone it is possible to deliver over 275,000 electrical horsepower from steam, gas engine and hydro-electric stations, the long distance transmission being at high potential, and from one station over 352 miles. Another city can be supplied with over 135,000 electrical horsepower.

It is estimated that for the territory including Arizona, California, Idaho, Nevada, Oregon, Washington, and British Columbia, the water horsepower which has been filed upon, but not yet developed, is 4,500,000.

The 2 leaders in electrical development are California with 555,000 kilowatts, and Washington with 164,000. Of these in California 254,000 kilowatts are hydraulic, 288,000 steam, and 13,000 gas. The division between alternating and direct current is 527,000 kilowatts for the former and 28,000 for the latter. In Washington the figures are, water 106,000, steam 58,000, gas 120 kilowatts, while alternating current has 155,000 and direct current 9,000.

In the total territory above mentioned including the Hawaiian Islands the water power development is 497,000 kilowatts, steam 409,000 and gas 150,000; alternating current is used by 873,500 and direct current by 47,300.

PURIFICATION OF AIR by the use of electricity has met with great success at the Chicago Public Library. 10,000 cu. ft. of air a minute are treated and given a charge of ozone, which results in the freshness of mountain air in the reading rooms which have heretofore had the disagreeable odor characteristic of rooms where large numbers of people are continuously sitting. It also keeps all books and papers in hygienic condition, doing away with the necessity for disinfecting.

ON ACCOUNT OF THE GREAT damage done to automobile tires by running them improperly inflated a regular fixed schedule of air pressures has been computed, based upon the size and weight of load. For 3½-in. tires, 60 lb. is recommended; for 4-in. tires, 75 lb.; for 4½-in. tires, 85 lb.; for 5-in. tires, 90 lb.; and for 5½-in. tires, 95 lb.

THE ART OF CURVE PLOTTING

FOR QUICK AND CORRECT COMPARISON OF VALUES

BY C. S. M'GINNIS

LIKE everything else in engineering practice, there is a right way and a wrong way to plot curves. Curves appeal to the eye, they tell us relations at a glance, and substitute for wearisome and unconnected columns of figures easily read lines. The practice is universal but correct understanding of it is not universal.

The Experiment

In measuring the resistance of a coil of wire by the Wheatstone bridge, if the temperature of the coil changes, its resistance will likewise change and we wish to know what the relation is between its resistance and its temperature, say from 10 to 100 deg. Centigrade. We will measure the resistance R of the wire at various temperatures T from 10 to 100 deg., approximately. The results are as follows:

R = resistance of coil in ohms.	T = temperature of coil in deg. C.
10.42	10.5
10.94	29.5
11.32	42.7
11.80	60.0
12.24	75.5
12.67	91.0

The measurements of R are reliable to 0.01 ohm and T to 0.1 deg.

Choice of Plotting Paper

A convenient size is a paper 8 by 10 in. ruled in 0.5-in. squares and these each ruled in tenths making the smallest division 1/20 in., or there is another extensively used which is ruled in centimeters which are subdivided into millimeters.

The Terms Employed

A reference point called the "origin" is first chosen and is generally taken at the lower left hand corner of the paper but this rule has many exceptions for the origin, as will be seen presently, is sometimes taken entirely outside the sheet of paper. All distances measured to the right or left of this origin are called abscissas, while all distances measured up or down are called ordinates. By the scale of the plot is meant the number of units represented by one unit of length such as 10 deg. to 1 in. The axis of abscissas is a horizontal line drawn through the origin while the axis of ordinates is drawn vertically through the origin; the distances in any plot are measured from these 2 axes. These are the few common terms always used in plotting.

Choice of Scales

The beginner often wants to choose the same scale for both abscissas and ordinates. This is wrong as oftentimes the picture of the plotted data will be a line either nearly horizontal, or else nearly vertical; one is as bad as the other; in either case the real precision of the data obtained by experiment will be sacrificed, that is, if one cannot read the temperature off the plot to within 0.1 deg. C., what a waste of time to measure it so close. Evidently the scale chosen has to suit the precision of the data and so this must be looked out for before the plot is made. Thus, to get the best precision in the reading of both ordinates and abscissas, the line should be inclined at an angle of 45 deg. with both axes, a deviation of 10 deg. on either side being allowable.

The scales, moreover, ought to be convenient, such as 1 in. or centimeter equal to 1, 2, 5, or 10 units—never 1 in. or centimeter equal to 3, 7, or 11 units, for this besides involving a great deal of work, makes us more liable to error. In our experiment the total change in R is about 2.2 ohms and in T about 90 deg. C. so that, in order to distribute these quantities well over the paper with which we have to deal, let us use 1 centimeter equal 0.2 ohm and 1 centimeter equal 5 deg. C., for these are convenient numbers and the data will not be crowded on either axis. Here is a good example where the origin will not come on the page for the resistance never falls below 10.4 ohms; hence, there being no value of R from 0 to 10.4 ohms, why allot space to this when there is no advantage to be gained, and which would require a much longer paper than we have?

To plot the data, never use dots, for a dot large enough to be seen plainly is too large to indicate a true point, and in many cases the true point is not in the center of the dot. Instead, draw vertical and horizontal lines lightly and about 1/8 in. long, and use their point of intersection.

In all cases, that measurement which is to be looked up when the curve is to be consulted, should be plotted as ordinates (along the vertical axis). Thus we must plot the resistances as ordinates since the resistance is the unknown quantity to be obtained from the curve at any desired temperature.

Best Representative Line

This is something very important. The data being plotted, the next step is to draw through the points a smooth curve. If the points appear to lie on a straight line, the best representative line may be located by moving a fine black thread among the points until a position is found such that the points above the line deviate from it by the same amount as those below it. The exact location of this line should be this: Adjust it among the points so that the sum of the squares of the deviations of the points above the line is equal to the sum of the squares of the deviations of the points below the line. Don't be inquisitive enough to ask why this is true; this is the "Criterion of Least Squares" and can be mathematically proved. The position once determined, note 2 points through which the thread passes and connect by a fine line.

Many times we are not lucky enough to have a straight line indicated, but instead, the points deviate systematically from a straight line and so our best representative curve must be made with a French or flexible curve. Here is a good place to advise every reader who does much curve plotting to have a flexible curve. It is a labor saver and a time saver and for practical results is entirely ahead of the old French variety whose rigid sides require so much poor patchwork to be done. See Figs. 1 and 2 for a correct and an incorrect plot of our resistance results.

Equation of the Straight Line

Don't gasp at the word theory because what follows is within the grasp of anyone who understands

arithmetic. A practical man should not be scared at the mere mention of analytic geometry for he can use the results of this study with absolutely no knowledge of it. We want to get our results in the form of a little expression like this,

$$R = aT + b$$

where a and b are 2 numbers which we shall absolutely know and so we shall be in a position to find R (resistance) for any temperature T by merely multi-

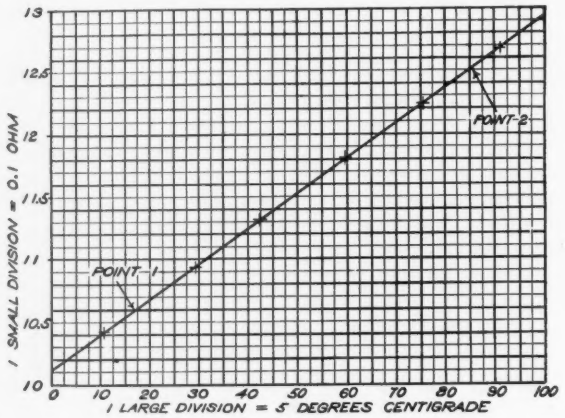


FIG. 1—CURVE CORRECTLY PLOTTED

plying this T by the number a and then adding to this product the number b. This can all be done from our plot.

First to determine the constant a, select any 2 points on the line, preferably near the extremities. Call one point No. 1, the other No. 2. We can read off the abscissas and the ordinates of both points.

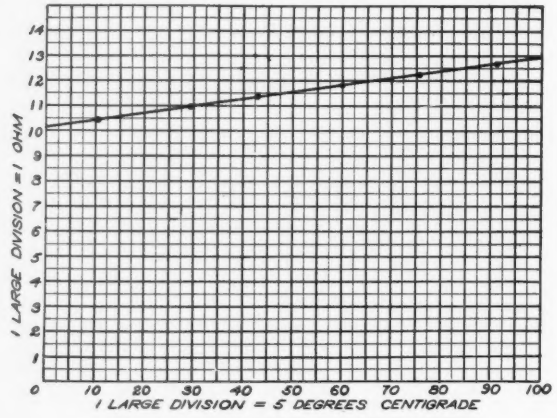


FIG. 2—INCORRECTLY PLOTTED CURVE

a = (ordinate of No. 2 — ordinate of No. 1) ÷ (abscissa of No. 1 — abscissa of No. 1).

So we have, consulting Fig. 1, a = (12.51 — 10.53) ÷ (85 — 15) = 1.98 ÷ 70 = 0.028.

Constant b is simply the value of the ordinate where the line cuts the axis of ordinates, i. e., b = 10.11. The desired equation connecting R and T is then, R = 0.028 T + 10.11. Now to find the resistance of our coil at any desired temperature, we simply have to do a little arithmetic. We could have used the Fahrenheit scale of temperature throughout in exactly the same manner. It should be kept in mind that this is not a single isolated calculation which has no general application, for similar cases occur over and over again in engineering practice.

A Curved Best Representative Line

While the straight line is frequent in practice, there are many cases where a curved line, often a parabola, results. The straight line means simply this; for every definite numerical change in the abscissas, the same definite numerical change always takes place in the ordinate, no matter where this change occurs on the axes. Thus for every change of 9 deg. C. in the temperature of the coil, a corresponding change of 0.52 ohm takes place in its resistance. The plot will clearly show this.

This relation, however, does not hold, if the plotted line is not straight. In this case any definite change or difference in values of abscissas taken along the axis will show different intervals on the axis of ordinates; so, if our temperature-resistance line had been curved, a change of 9 deg. in temperature would not have caused the same change of resistance when the 9-deg. interval was taken at various places along the temperature axis. The equation to this parabola is often stated in the following form, $R = a + bT + cT^2$, where the letters a, b and c represent constant numbers which are obtainable from the curve, so again the resistance at any temperature may be obtained without reference to the curve merely by the application of a little arithmetic. I will not review the method of obtaining the latter equation since it is far easier to consult the plot, first finding the temperature of the coil, and then reading its corresponding resistance directly from the plot.

Extrapolation

Although we measured the resistance of the coil as low as 10 deg. C., it should be noted that the straight line may be extended downward, thus allowing us to read off the resistances at temperatures lower than we actually measured, i. e., lower than 10 deg., say at zero degree C. But is this allowable? Decidedly no. The plot should be used only between the limits actually tried experimentally, that is, from 10 to 100 deg., and so our formula is good only within these limits of temperature.

But this so-called extrapolation may be used merely as an approximation or indication and in many cases it is found to be extremely useful. If the experiments were actually carried out between—5 and 10 deg. C. and the results plotted, the line would no longer be found straight. It is an interesting fact that if the temperature-resistance curves of most pure metals are extended backward, the curious result is obtained that —273 deg. C. is the temperature at which the resistance of these various metals is zero. The lines all point toward this position on the plots, but of course this extremely low temperature has not been realized in practice, and so the curious result is simply obtained from an extrapolation.

THE PORTLAND, ORE., RAILWAY, LIGHT & POWER Co. is again increasing the capacity of its hydro-electric plant. It has recently placed an order with Allis-Chalmers Co. for a 3,750-kw., water wheel type 11,000-volt, 60-cycle, 3-phase, 300 r.p.m. alternator. This will be of the same general design as the 2 2,500-kw., 11,000-volt, 33-cycle alternators already supplied, and will be semi-enclosed. A 50-kw., 120-volt exciter will be direct connected to an extension of the alternator shaft.

GREAT ENERGY is not necessarily accompanied by noise. The sunbeam gives a horsepower, 33,000 ft. lb. a minute, to each 10 sq. ft. of the Earth's surface, but there is no squeak or rattle or groan about its action.

THE METHOD OF DESIGNING A COIL SPRING

RULES FOR SAFE LOAD AND DEFLECTION AND ILLUSTRATIVE EXAMPLE

IN THE design of a coil spring, the things which are necessary to determine are, the size of wire, the diameter of the spring, the length of spring, the weight which the spring will carry, and the amount of play, or compression and expansion, that the spring will safely stand. Depending on the conditions, 2 or more of these things may be known, but usually the things which are given are the weight to be carried, and the amount of play allowable. With these 2 things given, the values to be determined are, the size of wire, the size of the coil, and the length of spring needed.

Of course, any number of combinations may be made which will answer the given requirements, but frequently the place where the spring is to be used determines either the diameter of the spring or the length allowable, and the determination of the other 2 dimensions is then required. A large amount of play demands a long spring and a great amount of weight calls for a large size wire.

Safe Load

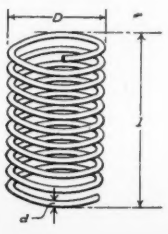
In his book on Machine Design, Prof. C. H. Benjamin gives the following rule to get the safe working load on a spring: Multiply the safe torsional strength of the wire by the cube of the diameter of the wire, and divide by the product of 2.55 times the mean diameter, of the spring. This mean diameter will be the outside diameter of the coil minus the diameter of the wire.*

Prof. Benjamin states that a series of tests on springs, made at the Case School of Applied Science, showed that for spring brass the safe torsional strength is 2,500 pounds, while for steel this varies with the ratio of the diameter of spring to diameter of bar and with the size of wire. For bars less than 3/8 in. diameter, with the diameter of spring 3 times the diameter of wire the safe stress is 112,000 lb., for a diameter of spring 8 times the diameter of wire the safe strength is 85,000; for wire 7/16 to 3/4 in. diameter, with coil diameter 3 times the wire diameter the safe strength is 110,000, and with coil diameter 8 times the wire diameter the safe strength is 80,000. For bars 13/16 to 1¼ in. in diameter, with a ratio of spring diameter to bar of 3 the safe strength is 105,000, and with a ratio of spring diameter to bar of 8, the safe strength is 75,000. For bars over 1¼ in. in diameter a stress of more than 100,000 lb. should never be used, and if a spring is subjected to sudden shocks, a smaller value of torsional strength should be used than is otherwise necessary.

The rule given above for the safe working load on a spring applies to a spring made of round wire. If the spring is of square wire, the same form of rule applies but in place of 2.55 use 2.12.

Safe Deflection

The other thing to be determined, the safe amount of play or as it is called the deflection of the spring is found as follows. Multiply the length of the wire in the spring by the mean diameter of the spring and by the safe torsional strength, and divide this by the product of the modulus of torsional elasticity multiplied by the diameter of the wire.†



*In the form of an equation,

$$L = \frac{S\,d^3}{2.55\,D}$$

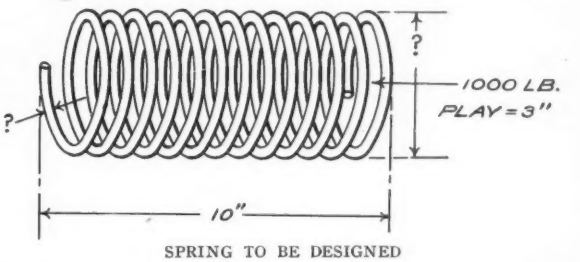
where L = safe load for round wire; S = safe torsional stress; d = diameter of wire in inches; D = mean diameter of spring in inches. For square wire substitute 2.12 for 2.55 in the denominator.

This applies to round wire and the same rule applies to square wire, excepting that the final quotient is to be divided by the square root of 2. This modulus of torsional elasticity is for spring brass, 6,000,000 and for steel 12 to 18,000,000, the average being 14,700,000 or for safety 14,500,000.

It was found by experiment that springs of small diameter can be safely subjected to a higher stress, than those of larger diameter.

Example

To apply this rule to an actual case; suppose that a spring is to be designed to carry a weight of 1,000 lb. and have a play of 3 in., and that the length of the spring from end to end is to be 10 ins., required to find the diameter of the spring and the diameter of wire to be used.



SPRING TO BE DESIGNED

The rules as given do not apply directly to such a problem and it is necessary to assume some diameter of spring and size of wire which appeals to us as about right and see whether it will safely carry the load or not.

After this is done it becomes an easy matter to find by proportion what size of spring is necessary or what size of coil is necessary to give us the spring desired. Heavy springs are usually made with the space between wires in the spring equal to the diameter of the wire. Assume as the diameter of the wire 0.25 in. and the mean diameter of the coil 2 in., then from our rule the safe working load would be $85{,}000 \times 0.25^3 \div 2.55 \times 2)$; working this out gives a product of approximately 261 lb. as safe load which is of course only about ¼ of the required load.

The safe working load increases as the cube of the diameter of the wire and decreases as the diameter of the coil, hence we must make this spring of a larger wire or make the coil of smaller diameter. The diameter is as small or smaller than should be used for a spring which is to carry 1,000 lb., hence it would be better to increase this to 2.5 in. rather than decrease it, and then increase the size of the wire as needed.

To find the load that the spring would carry if it were made out of wire 0.25 in. diameter, and 2.5 in. in mean coil diameter, we have the proportion; 261 is

†In the form of an equation;

$$P = \frac{WD \times S}{E \times d}$$

where P = safe play in inches for round wire; D, S and d as before; E = modulus of elasticity. For square wire divide P as found above by 1.414.

to the required load, as 2.5 is to 2, which gives about 209 lbs.

We want to find then what diameter of wire will carry the required load of 1,000 lb., and from this proportion we get; 209 is to 1,000 as 0.25^3 is to the cube of the required diameter. Working out this proportion we find for the cube of the diameter 0.0748 and extracting the cube root of this gives about 0.42. The nearest size of wire to this is 0.43 in. diameter which is No. 50 in the Washburn and Moen Gauge. This determines the size of wire to be used.

The next step is to find out whether the amount of play required can safely be had with this size wire and coil. The indeterminate factor in our rule for finding the safe play is the length of wire in the spring. To get this we multiply 9.87 by the square of the diameter of the coil and by the number of turns squared; add to this the square of the length of the spring from end to end and extract the square root of this sum. In this case, since we are to have the space between wires equal to the diameter of the wire the number of coils will be $10 \div 0.86 = 11.6$, and the square of this is 135. The square of the diameter of the coil 2.5 squared is 6.25 and multiplying together $9.87 \times 6.25 \times 135$ gives 8,340. The square of the length of the spring is 100 which added gives 8,440, and the square root of this is 91.8. Our rule for safe play then gives us $91.8 \times 2.5 \times 85{,}000 \div (14{,}500{,}000 \times 0.43)$; and working this out gives 3.03 in. as the safe amount of play. This is almost exactly the amount required by the problem, hence the spring will be right for the required service.

DISCHARGE FLOW OF WATER THROUGH PIPES

BY CHARLES J. MASON

THE flow of water through pipes depends upon a number of conditions that are variable and so when it is asked how much water will be discharged from a given pipe in a stated time, it is somewhat difficult to find a formula or rule that quite suits the case. But for a basis of comparison and in order to give the reader an idea of how he may proceed, the following formula may be used, with certain modifications to suit each case.

The gallons of water a minute which may be discharged through a given pipe of known diameter and length, suction lift in feet, water supplied under atmospheric pressure, assumed coefficient of friction, and degree of vacuum carried (or the degree of absolute pressure existing in the pump cylinder, may be found from this rule:

The Rule

Raise the diameter of the pipe expressed in inches to the 5th power, i. e., multiply it by itself 5 times; then multiply by the head tending to cause flow, expressed in feet; divide the result by the length of the pipe in feet and by the coefficient of friction; extract the square root of the quotient and multiply this root by 2.83, a constant.*

Coefficient of Friction

In relation to the coefficient of friction the following will be of service to the interested reader: the figure 0.01 represents a bad condition of piping, such as when mine water is handled; 0.02 may be used when the interior of the pipes are in very bad condition. But when average pipe conditions prevail then 0.06 may be used as the factor, up to and including pipes of 12 in. diameter. In an average plant having pipes of larger diameter than 12 in., the coefficient may be as low as 0.001, when good conditions obtain thoughout the system of piping.

From the foregoing a coefficient may be selected to suit almost any kind of a case that might come up for solution, with a reasonable degree of accuracy, sufficiently close for practical purposes at any rate.

Illustration

As an example and illustration to show the application and method of operation of the formula, let us take this example: A pipe 600 ft. long, 8 in. diameter, straight, with no leaks and in a condition that warrants the use of the coefficient 0.01; the pump is at sea level, suction lift is 12 ft., vacuum 22 in., or an equivalent pressure of 4 lb. absolute per square inch.

The value of the head in the rule is found as follows: Thirty-four feet is the head due to 14.7 lb. per sq. in. atmospheric pressure (as 1 lb. = 2.31 ft. head). Twelve is the number of feet suction lift, or the height through which the water is raised from the source of supply to the pump cylinder. Hence it must be subtracted from the original 34 feet. Ten feet is found from the 4 lb. absolute pressure existing in the pump cylinder, $4 \times 2.31 = 10$ ft., which is the equivalent feet head due to 4 lb. pressure per sq. in., so that the 10 feet also must be subtracted from the original 34 ft. head. The final value of the expression becomes, $34 - 12 - 10 = 12$ ft. head.

Eight raised to the 5th power = 32,768 and this times 12 and divided by 600 and by 0.01 gives 65,536; the square root of this is 256 nearly and this times 2.83 = 724.5 gal. per min.

Using the formula:

$$G = 2.83 \sqrt{\frac{12 \times 32{,}768}{0.01 \times 600}} = 724.5$$

or say 700 gallons to allow for inaccuracy in the coefficient.

Derivation of the formula is of no particular use to a person who only wants a formula to use. It is simply offered as a tool so to speak, and as shown in the illustration it will give an idea at least as to what may be expected.

To get cubic feet per minute multiply the gallons as found by 0.1336.

STANLEY G. FLAGG & CO., OF PHILADELPHIA and Pottstown, have recently contracted for a 300 hp. gas producer and gas engine dynamo installation to be used in connection with their steam plant. We believe that such combinations of steam and gas plants will grow more and more in favor as their great economic possibilities are recognized. The steam plant will be used to the extent of the possibility of reusing the exhaust steam and the gas engine plant for the rest of the load.—The Isolated Plant.

REPAIRS MADE IMMEDIATELY when they are needed may give you a Sunday off.

*Expressed as a formula this becomes

$$G = 2.83 \times \sqrt{\frac{h\, d^5}{f \times L}}$$

in which the values are: G = gallons discharged per minute; 2.83 = a constant; L = length of pipe in feet; h = head force in feet; d^5 = diameter of pipe in inches to the fifth power; f = coefficient of friction.

INFLUENCE OF THE CONSTITUENTS OF COAL ON THE EFFICIENCY AND CAPACITY OF BOILERS*

BY D. T. RANDALL†

IT is difficult to burn all coals with equal efficiency. This may be due to either the character of the coal, the size of the coal, or to both. Having a large number of tests on different coals, one may by systematic study draw some general conclusions regarding the influence of moisture, volatile matter, and in extreme cases possibly on the effect of the presence of ash in the coal. Unfortunately for the purpose of comparison, the coals high in moisture are usually high in volatile matter and ash as well.

The Influence of Moisture

It is of course understood that any moisture in a coal reduces the heating value accordingly. In addition to this influence, there is a further loss due to the absorption of heat in the furnace, which lowers the temperature of the gases, causing a larger percentage of loss in the gases escaping from the boiler. This influence is not readily seen when burning coals which have only a slight variation in the moisture content, but in cases where there is an excessive amount of moisture this influence may be readily traced, as in western lignites in which the moisture sometimes reaches 40 or 45 per cent of the weight of the fuel. On the other hand there are many people who believe that a certain percentage of moisture is favorable to good combustion and as has been indicated above, the influence of moisture is so small that its effect cannot be separated from the many other influences which affect the results of a boiler test.

In 2 coals tested, one of which ran from ¼ to ¾ in. diameter, and the other ⅜ to ⅞ in. the corresponding moisture was 10.72 and 19.83 per cent and the ash was about the same in both; the volatile matter ran 39.59 and 42.61 respectively, and the heat values, 11,898 and 10,274 B. t. u. Spite of these showings, the efficiencies were 66.89 and 70.39 for the boiler and grate when the 2 coals were used. The difference was probably due to the size of the coal.

Influence of Volatile Matter

With a poorly designed furnace the volatile matter in a coal is allowed to escape unburned even when the fuel is burned at moderate rates. With well designed furnaces a loss of combustible gases is found when they are operated beyond a certain capacity, varying with the furnace, and with the kind of coal.

A series of tests made at the Government Testing Plant shows the effect of proper and improper furnace conditions on burning of coals with volatile matter. The first series was made in a house heating furnace where the firebox has iron surfaces, the rate of combustion is low, and the gases are cooled as soon as they escape from the coal. It is therefore badly adapted for the burning of soft coals. The second series of tests was made in a hand fired Heine boiler with a fire brick combustion chamber.

With the house boiler, coal, having a percentage of volatile matter when free from moisture and ash of 18.30, the efficiency was 60.56 per cent and the smoke 18.2 in the scale of blackness; with 34.7 per cent volatile, the efficiency was 54.11 and the smoke 22.1; with volatile matter, 44.46, the efficiency was 47.19 and the smoke 32.9.

With the Heine, a coal having 17.47 volatile gave an efficiency of 67.16 per cent and smoke 3.1; with the volatile 34.48, the efficiency was 67.24 and the smoke 12.9; with the volatile 44.13, the efficiency was 65.25 and the smoke 18.0.

Influence of Ash

For small variations in the percentages of ash it is not possible to determine the effect on the results obtained. The character of the ash is of more importance than the quantity when considering its effect on the results obtained. Clinker and ash reduce the efficiency and capacity by making it necessary to hold the doors open longer in cleaning the fire, and in case the ash fuses and runs on to the grate bars, the air is shut out, the grates may be burned, and the results be affected by the imperfect air supply. A large percentage of ash tends to make the distribution of air through the fuel bed uneven, requiring a much larger air supply than is necessary for other coals.

Large quantities of ash also cause a loss of unburned coal due to the poking and to the frequent cleaning of the fire. When the coal contains a high percentage of ash the labor of feeding the furnace with the extra quantity of fuel, the cleaning of the fires and the handling of the ash may make it necessary to employ extra help in the boiler room. There is also an additional expense in hauling the refuse away from the plant. The extra quantity of ash may make it impossible to burn a sufficient quantity of coal upon the grate surfaces provided and require an extra boiler to be operated. This causes a further loss due to the extra labor, radiation losses from the boiler, etc., however. With moderate quantities of ash in the coal no serious loss should result when the furnace is properly handled.

Influence of Sulphur

There is not sufficient data at hand to discuss in general the effect of sulphur in coal. There are coals from certain fields that usually give trouble when the sulphur is high. This is due not only to the sulphur in the coal but to the combination of iron and other elements with the sulphur, and the sulphur is merely an indication of probable difficulty that may be experienced. When sulphur occurs in combination with iron the grate bars are often attacked and seriously damaged, requiring expensive renewals of iron work.

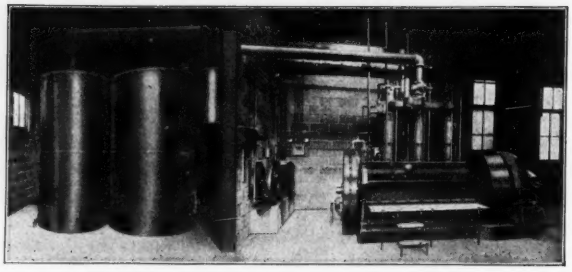
*Presented before the American Society for Testing Materials.

†Fuel Engineering Department, Arthur D. Little Laboratory, Boston, Mass.

CORRECTION NOTE

In the article on Furnaces for Babcock & Wilcox Boilers in our January issue, Page 65, there is an omission which changes the meaning of one sentence entirely. Near the end of the first paragraph is the clause: "But it must be assumed that these are the only furnaces recommended." This should read: "But it must not be assumed that these are the only furnaces recommended," which is distinctly different. The fault is ours and not that of the Babcock & Wilcox Co.

Gas Producers



And Engines

NON-SOOTING PLUG FOR GASOLINE ENGINE

BY GEORGE J. MURDOCH

ABOUT 6 yr. ago the writer installed a 10-hp. gasoline pumping engine, equipped with a hammer spark igniter, which was said by the makers to be the best in use. The engine ran about 3 weeks 12 to 15 hr. a day, and then for some at that time unaccountable reason, would not budge.

After considerable delay, and expense it was found that a deposit of carbon had formed on the insulation of the igniter, cutting out the battery current. It made so much trouble from time to time from this cause that efforts were made to find some means to prevent it, particularly as the manufacturers of the machine while admitting the defect seemed powerless to remedy it, and the outcome was the plug shown in the illustrations herewith. The engine has now run 3 yr. with no trouble whatever from this source.

Details

The cast-iron block on which the igniter is mounted is the one that came with the engine, but a hole

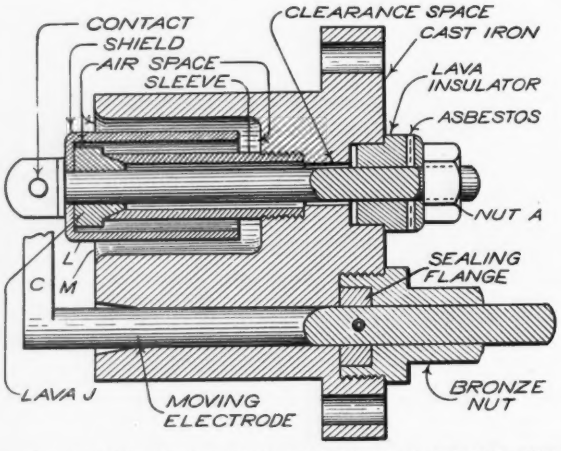


FIG. 1—THE SPARK PLUG COMPLETE; SECTIONAL VIEW

was bored as shown in Fig. 2 at B in the inside end of the block, and into the bottom of this hole at E was screwed a steel sleeve F. The outer end of the sleeve has an internal taper which receives the lava insulator J, and at D on the block another lava insulator is fitted. The stationary electrode passes through these insulators without touching the steel sleeve or the cast-iron block as shown in Fig. 1. A nut A, Fig. 1, secures the battery wire to the stationary electrode, and a thinner nut is screwed on the electrode against an asbestoes gasket that draws the taper of the lava insulator against the end of the steel sleeve, and makes a joint gas tight, yet that allows for expansion, and contraction of the rod which forms the electrode.

Between the head of the stationary electrode just described, and the lava insulator is a steel cup-shaped shield which sets into the hole B of the igniter block, but clears both it and the steel sleeve F. The moving electrode is of the usual construction with a sealing flange, which is held against the block by a bronze nut as shown in Fig. 1, screwing into the thread G of Fig. 2.

The snap action is secured to this electrode in the ordinary way by a crank at C, Fig. 3, and the breaking of the circuit which makes the spark in the engine cylinder is accomplished every other revolution as is common in 4-cycle engines.

How it Operates

Without the steel shield, carbon would soon form on the lava insulator J, and make a path for the electric current between the stationary electrode, and the

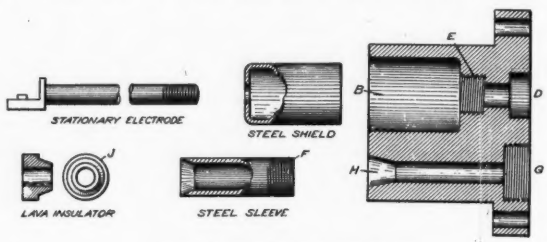


FIG. 2— DETAILS OF PLUG

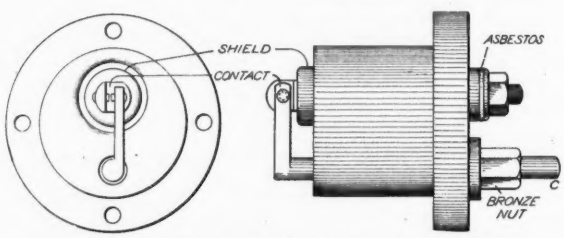


FIG. 3—THE NONSOOTING PLUG ASSEMBLED

sleeve, cutting it out and stopping the engine. Another bad feature of this action is, that during the forming of the carbon on the insulator it makes a path for the battery current, and before the igniter has reached a point where it refuses to fire the charge in the engine cylinder, there is a useless waste of the batteries going on. It has been found that when this extra waste is stopped the battery cells last nearly twice as long, and that there is much less miss-firing.

With the shield shown, however, carbon cannot

form on the insulation for the following reasons: When the engine starts it draws in its explosive charge, which is forced by the compression into all recesses opening into the cylinder. The air space between the inside of the cup or shield, and the sleeve F is very small, about 1/16 in., and the explosive mixture cannot displace the pure air in this space as it strikes it evenly all around the annular opening. Therefore, no explosive mixture is next to the insulator J, and when the charge is fired there is nothing to ignite, consequently no carbon can be formed.

This is the writer's view of the reason why the formation cannot take place, but whether correct or not, it is certain that after several years running the inside of the cup, the steel sleeve, and the insulation are as clean as when new, not the least trace of carbon being observable, although it has formed on the outside end of the shield, and parts facing the combustion chamber of the cylinder more than 1/16 in. thick.

It was thought that carbon might bridge over at the points L, M between the shield, and the igniter block, but no evidence of any such action has been shown, and it is now the writer's belief that the constant compression, and release of the charges in the space B occupied by the shield, and sleeve as well as the shock of the explosions is the reason why no such connection is made although the carbon all around the hole, and on the shield is amply thick to make it. A slight deposit gradually tapering to nothing forms on the shield near the outside end and also on the outer end of the bore of the hole B. This deposit runs down into the hole about 0.75 in. and disappears.

The shield has made no trouble from getting hot, and the whole outfit is a great improvement over the old igniter which had to be pulled off the engine and scraped every 3 or 4 weeks, to say nothing of the cost of battery cells which has been cut nearly in half.

LONDON LETTER

RECENT IMPROVEMENTS IN GAS ENGINE GOVERNING

BY W. A. TOOKEY

CONSIDERABLE attention has been given during the last year or 2 by British Gas Engine makers, to the improvement of governing devices and particularly with a view to obtaining regulation by some system of throttle governing instead of hit and miss, which has hitherto been practically universal. The different firms, however, do not appear to have decided unanimously to adopt 1 of the

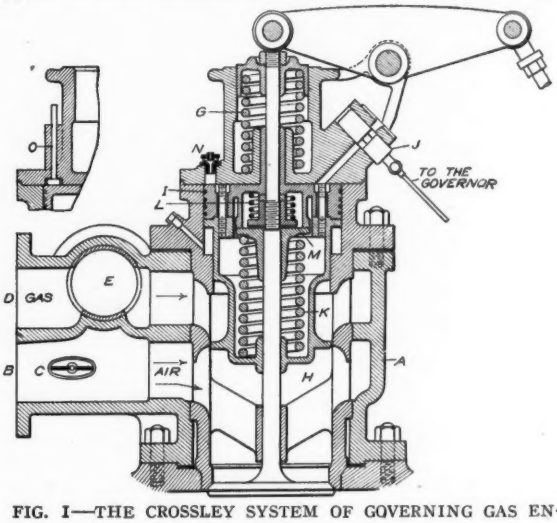


FIG. 1—THE CROSSLEY SYSTEM OF GOVERNING GAS ENGINES

2 systems of throttle governing available to the exclusion of the other, and quite as many have designed their governing mechanism to provide a uniform mixture of varying volume, as those who prefer to retain a constant compression pressure varying only the volume of gas admitted per cycle.

Thus the well-known firms of Crossley Bros., Ltd.; the Campbell Gas Engine Co., and the Premier Gas Engine Co., and several smaller makers, govern by varying the richness of the charge, while the National Gas Engine Co., Richard Hornsby & Sons; Tangyes Limited, and some others, arrange for a variable lift of the inlet valve governing both ingredients.

The Crossley Method

Messrs. Crossley's device is shown in Fig. 1, and consists of a valve box A, in the lower portion of which air is admitted by the branch B, the quantity passing being regulated to suit the quality of gas with which the engine is working by means of the butterfly valve C. In the upper portion of the casing, gas enters by the branch D, and the volume can be

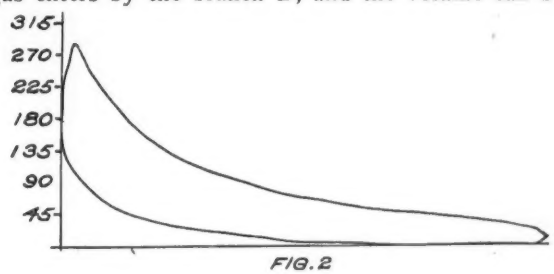


FIG. 2

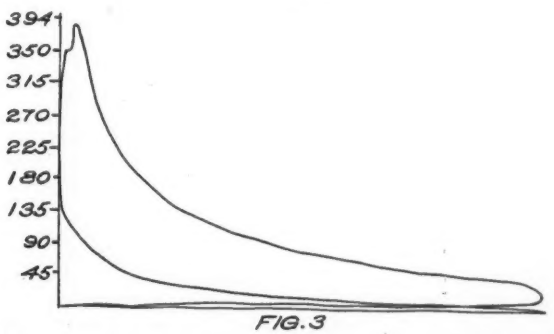


FIG. 3

FIG. 2—CARD FROM GAS ENGINE UNDER NORMAL CONDITIONS

FIG. 3—CARD FROM SAME ENGINE AS FIG. 2; SHOWING ACTION OF CROSSLEY GOVERNOR IN SUPPLYING RICH GAS MIXTURE

adjusted by means of the plug-cock E, both gas and air being admitted to the cylinder through the main inlet valve. The movement of this valve is derived from the usual cam, rod and lever from the side shaft and the main inlet valve is depressed. This com-

presses the coil spring G within the valve box cover in the usual manner. The gas valve H is mounted upon the same spindle, but its movement is graduated to suit the load by means of the vacuum piston I, so that any depression of the inlet valve spindle would merely compress the coil spring shown within the gas valve H. The vacuum piston ensures that the downward movement of the vacuum piston I attached to the valve H, is dependent upon the quantity of air admitted through the aperture at the back of the

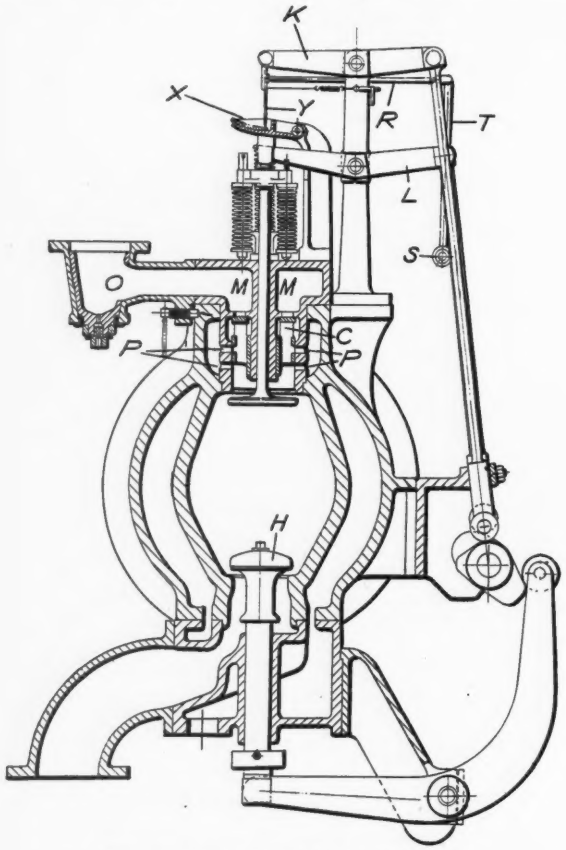


FIG. 4—PREMIER GOVERNING DEVICE

vacuum piston as regulated by the small plug J, which is moved more or less within a cylindrical aperture by the governor.

In the interior of the vacuum piston a spring L is provided, the tension of which is adjusted by a coupling nut M, threaded on the main inlet valve spindle, so that in its downward movement the nut M compresses the spring K, tending to open the valve, which tendency is resisted by the vacuum piston in the manner before mentioned. In addition to the aperture adjusted by the plug J, a small valve N enables a restricted quantity of air to enter behind the vacuum piston, so that, at light loads, although the plug J may almost entirely close the aperture, a small movement of the gas valve always takes place. In order that the movement of the vacuum piston may be made visible to the attendant, a spindle O is provided, which rises and falls with the vacuum piston.

From tests made with this engine exceedingly good results have been achieved, the maximum variation in speed from full load to practically no load, being 1 2-3 per cent, when the load was dropped from 600 to about 50 brake hp. Repeated trials showed that the speed of the engine under such circumstances never varied more than the above percentage, so that this system of governing must be a very close and good one. The two diagrams in Figs. 2 and 3 were taken from an engine having two tandem cylinders, each 32 inches diameter by 36 inches stroke when developing 550 b. hp. Fig. 2 is a card taken from the engine under normal conditions, and Fig. 3 was taken to show the sensitiveness of the governor by momentarily throttling the gas supplied to the back cylinder, so as to throw more load upon the front cylinder, thus causing the governor to admit a richer mixture. The ready control is thereby practically demonstrated, the mean pressures varying from 74 in Fig. 2 to 85 in Fig. 3.

The Premier Co.'s Governor

The Premier governing device is shown in Fig. 4, the main inlet valve being operated in the usual man-

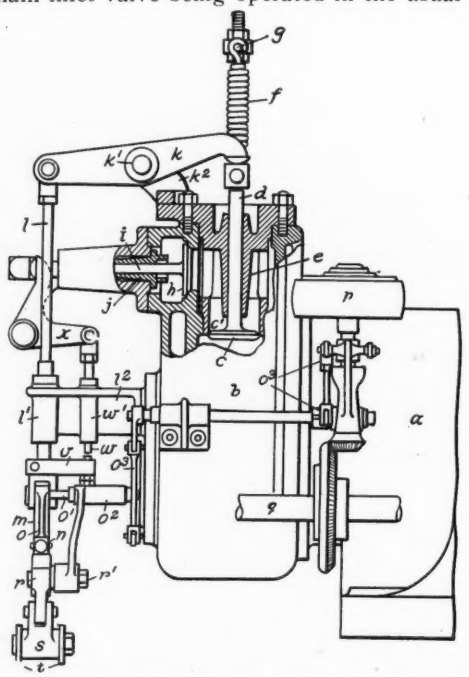


FIG. 5—HORNSBY & SONS SYSTEM OF GOVERNING

ner from the side-shaft by cams and the lever L. In this engine the governor partially rotates the shaft S, and thus the rod R varies the position of the finger Y upon the notched plate X, causing more or less space to be moved by the rod K before the gas valve is depressed.

In this manner, while the main inlet valve receives a constant stroke and opens and closes at unvarying positions before and after the suction stroke, the admission of gas takes place sooner or later during the suction stroke, as determined by the position of the finger Y upon the plate X. Therefore, the closing of the gas valve also takes place later or earlier. The gas valve spindle is connected to the circular slide C, which is depressed within the casing P, the aperture through the latter being more or less effective in consequence. The air enters through the adjustable cock O into the passage M, and passes through to the inlet valve at right angles to the gas apertures P, thus ensuring intimate mixture between the 2 ingredients.

This system of governing is effective and the Premier Co. has not found it necessary to make any variation in any single-cylinder gas engine it has con-

structed, even when of larger powers. By varying the depth of the plate X it will, of course, be seen that under no load the governor may be so constructed as to omit the gas charge altogether, and in this way the engine may operate on the hit and miss system under the lightest loads.

System of Hornsby.

The recently designed system of R. Hornsby & Sons is illustrated in Figs. 5 and 6, and in some respects it is similar to that of the Premier gear, but instead of operating upon the gas alone, it throttles the admission of both gas and air.

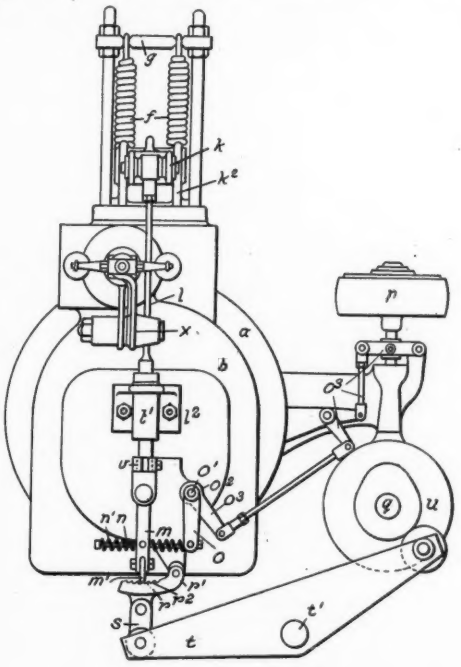


FIG. 6—HORNSBY

In these illustrations the engine cylinders are shown at a, the combustion chamber b being bolted thereto in the usual manner. The main inlet valve is shown at c, the valve spindle d passing through the removable guide e, and being attached to the tension springs f, supported by an upper cross-bar g. Gas valve h opens into the main inlet valve box, the spindle i passing through the guide j. The main inlet valve is depressed by the lever k, which receive its motion through the rod l. At the end of this is attached a radial member m, fastened on either side to springs n, and which is more or less deflected from the center line by the lever o. This lever is operated from suitable mechanism by the governor p, the latter being mounted upon the camshaft q.

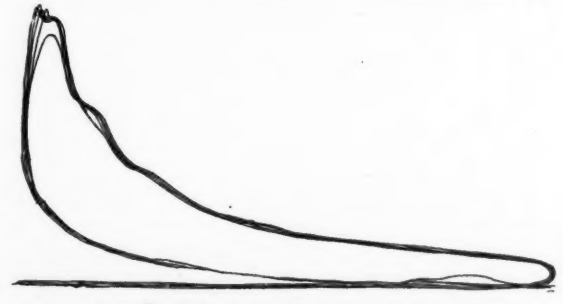


FIG. 8—DIAGRAM FROM TANGYE ENGINE

Motion of the rod l is obtained through the medium of the serrated plate r, linked by the short lever s to the valve lever t, which is operated by the cam u. In a suitable position upon the rod l above the swinging member m, a clamp v is attached, which thus communicates to the motion of the rod l through the plunger w, to the bell crank lever x. In this way both the gas valve and main inlet valve are operated from the same cam on the side shaft, and the relative timing of the gas and air valves can be adjusted by means of the set screw and lock nut shown attached to the clamp v.

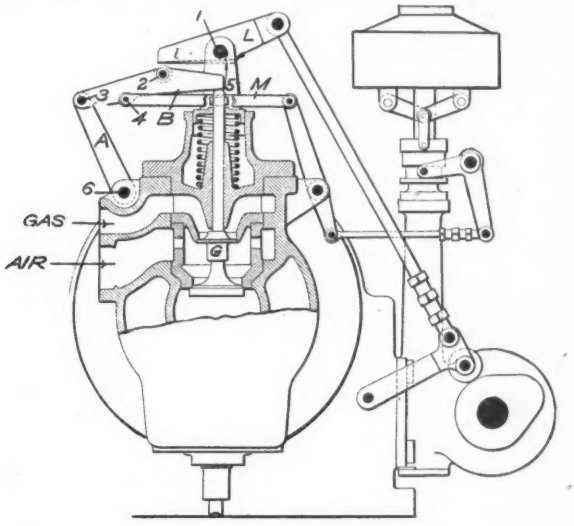


FIG. 7—TANGYE GOVERNOR

Action of the governor causes the finger m to be swerved to the right or left, according to the load, and thus the moment of contact between the end of the finger ml and the serrations r2 is varied, notwithstanding the cam u always gives the same lift to the plate r. By such means the gas and air admitted are always in constant proportion, and the time of opening and closing of the main valve is varied. The arrangement appears to be more complicated than it really is, and it is claimed to give very good results in practice.

FIG. 9—VARIATION OF DIAGRAM WITH VARYING LOAD

The Tangye Mechanism

The Tangye governing mechanism is illustrated in Fig. 7. In this engine the main inlet valve is operated by means of the usual lever and rod in contact with the cam, but instead of the lever 1 being brought into contact directly with the main inlet valve spindle, it is made to bear upon a roller 2, carried by a link B, fulcrumed at 3 to the lever A. This in turn is pivoted

at 6. It will be seen that the governor is attached to the link B at the point 4 by a rod M, and the duty of the governor consists in moving the link B, so that, under heavy loads, the full stroke of the valve is obtained, this being the position shown in the drawing, while under light loads the link B is moved to the right, and thus by reducing the effective leverage the main inlet valve spindle receives only a relatively small lift.

In this engine air is admitted through the bottom passage, and gas through the upper part. The gas valve G is fitted upon the main inlet valve spindle, and it will be seen that the governing of this engine is very close, due to the fact that there is no dead space for gas to remain between the consecutive cycles uncontrolled by the governor. Fig. 8 is an indicator diagram taken from a small Tangye engine having a cylinder 13 in. diameter, stroke of 20 in., running at 190 r. p. m.; the engine at the time was driving a dynamo by belt, the output of which was 110 amp. at 220 v. Fig. 9 is another diagram taken from the same engine showing the variation of charges due to slight fluctuations of load.

GAS PRODUCER TESTING

The United States Geological Survey is studying the general problems involved in the economic use of fuels in gas producers as part of its investigation of methods of increasing the efficiency of the fuel resources of the country, and declares that one of the important problems is the determination, under practically constant conditions, of the duration of gas producer tests necessary to reduce the possible error to a minimum.

Mr. Fernald, the consulting engineer in charge of these tests, says: "It is not uncommon to pick up advertising material that states a fuel consumption per horsepower per hour based on tests of 2 or 3 hours' duration only, in which the total coal charged during that period was from 20 to 30 lb. The producers in such tests are of course of small sizes, but the principle is the same for all.

"The initial fuel bed built up before the test is started amounts to several times the quantity of fuel charged during short interval tests, and the amount of gas that may be drawn from this foundation bed is an unknown quantity. It may be very small or may reach a large percentage of the total gas used during the short tests, depending on the carelessness or cleverness of the superintendent of the test.

"It is no wonder then that tests showing a consumption of only 0.6 lb. of coal per horsepower per hour are often reported; and apparently it is only necessary for some daring promoter to decide that a horsepower should be developed with a consumption of 0.25 lb. per hour for tests to be reported that show this figure.

"For accurate tests of gas producers and for a true determination of the fuel consumption, either the conditions of the fuel bed at the beginning and at the end of the test must be positively known, or the test must be of sufficient duration practically to eliminate the uncertainties that arise from varying conditions of the bed. Inasmuch as the first method is usually out of the question, it is necessary to resort to the second, at the same time securing as uniform conditions as possible in the fuel bed.

"A test should never be started when the producer has been standing idle for some time with 'banked fires,' as the fuel bed will not be in the average condition under which it will be required to work during the test; as the appointed hour for closing the test approaches, if the fuel bed is not in proper condition, the time of closing the test should be postponed until the bed naturally assumes the proper thickness and character. No forcing of conditions should be allowed simply to bring the test to an end at a previously determined hour."

POWER FROM COKE OVEN GAS

The adoption of gas engines operating on by-product coke oven gas is not only making good progress in this country, but the Japanese are also recognizing its advantages. The Furukawa Coke Works, Japan, recently ordered through Takata & Co., Japanese agents for the Westinghouse interests, an extension to the gas engine plant which has been in service for some time at its coke plant. The equipment ordered is a Westinghouse vertical single acting gas engine. A similar equipment has been ordered by the Imperial Printing Office of the Japanese Government, although not to operate on coke oven gas. Engines of the same size and type have been in operation for several years in the United States at the works of the Semet-Solvay Company, Syracuse, N. Y., and at the Otto Coke Works, Camden, N. J.

The most important application of by-product coke oven gas has occurred at Lebanon, Pa., where there are now located 2 plants aggregating several thousand horsepower. Both of these employ the Westinghouse horizontal double-acting type gas engine, coupled to alternating current generators for power, light, and traction service. All of the equipments are of standard Westinghouse construction, and one of these plants, which has been operating for more than a year, has thoroughly proved its adaptability, without requiring special design. This plant regularly operates on run-of-oven gas, ranging from 50 to 65 per cent hydrogen and one to two grains sulphur per cubic foot. This plant is located at the Lebanon Works of the American Iron & Steel Mfg. Company. The second plant under construction is located near Lebanon, at the works of the Pennsylvania Steel Company, adjacent to the extensive plant of the Semet-Solvay Company. Further important developments in this line are anticipated in the near future.—Electrical Record.

FUEL TESTS WITH HOUSE-HEATING BOILERS, by J. M. Snodgrass, is issued by the Engineering Experiment Station of the University of Illinois as Bulletin No. 31. Comparatively few tests have hitherto been made in connection with house-heating apparatus, and the results of this bulletin constitute a timely definition of its efficiency. The fuel used included anthracite coal, Pocahontas coal, and various grades of Illinois bituminous coal. The relative advantages to be derived from the use of these several fuels in house-heating apparatus are discussed and their relative value is defined. It appears that Illinois coal, while less efficient than others tested, supplies through its low cost the least expensive means of heating. The conclusion that the use of Illinois coals in such service must continue to increase is apparent. By the careful preparation of such fuel, the dirt, soot, and smoke resulting from its use may be materially reduced. Copies may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

STOCKHOLM, SWEDEN, HOLDS the record for the multiplicity of telephones among the cities of the world with 1 connected telephone for each 6.5 people. In the United States San Francisco tops the list with an average of 1 connected telephone for each 9.9 while New York, Chicago, Philadelphia and Boston are reported as having 1 in 13.5.

HOW NOT TO RUN A GAS ENGINE

BY C. E. BRYSON

The plant belonging to the Hoopeston Gas & Elec. Co., at Hoopeston, Ill., has been operating with producer gas engines and producers built by the Minneapolis Steel & Machinery Co. for some time and during the period covering 18 months' operation we have experienced all troubles to which such prime movers and generators fall heir.

We thought we had run the gamut from hot cranks to preignitions, but a strange experience which befell us a few nights ago leads us to think that there are still new fields to conquer.

Buckwheat coal is used in the producers, which are of the suction type, and on this occasion the coal bin being emptied, coal was scraped from the floor to use until the delayed shipment reached us. With these scrapings, of course went fine coal and dirt, which being wet would not readily screen, and was consequently carried into the producers. It took about 2 days for this dirt to work down onto the grates, and when it got there, it seemed to form into a more or less solid mass, which prevented the draft, (induced under the grates) from rising through the coal.

It was noted when running the smaller engine that it seemed to labor considerably, and when the large unit was started, its superior piston displacement (2 cylinders 21 by 32 in.) caused the water to rise in the scrubber until the water-seal-pot into which the scrubber drains, was sucked dry of water. This of course admitted air into the system and the engine died.

The water was allowed to drop to normal level in the scrubber, gas was forced over to the engine, the fires cleaned and the smaller engine was again started. It handled the load with difficulty, until increasing darkness compelled us to start the big engine. This time before starting, a hose at city pressure was turned into the seal-pot, in order that the previous performance should not be repeated, viz., the seal pot exhausted of water. It worked very nicely, although we were somewhat surprised at the continued rise of water in the scrubber.

Knocking sounds came from the interior, whether caused by large gas bubbles bursting or pieces of coke rattling against the sides, we could not determine. The engine underwent enormous labor, as well it might, holding that quantity of water in the scrubber in suspense, the air roared through the air intakes with a fearsome sound, the engine speed being about 75 per cent of normal. As the water rose in the scrubber, the engine seemed affected, but inasmuch as there was nothing else to do but to keep going, we hoped the water would cease to rise, before it got to the top. Once at the top, it would overflow into the dry scrubber and so into the piping and then we could amuse ourselves removing it while the engine was taking a rest.

Our scrubber is 6 ft. in diam. and about 11 ft. high and the water mounted in it as near as we could tell to a height of between 8 and 9 ft.

Naturally this imposed additional load on the engine, and it was necessary to run with the engine air inlet valve nearly closed. The water level in the scrubber began to fall gradually as the load fell off and at 11 p. m. had assumed its normal level. New fires were built in each producer alternately and at the end of 12 hr. the gas was again uniform and of a good quality.

Our equipment consists of 2 150-hp. anthracite producers 8 ft. high by 6 ft. diameter; 1 100-hp. single cylinder engine and 1 280-hp. twin engine, and we frequently average a kilowatt-hour at the switchboard on a pound and a half of coal (buckwheat). Our coal cost for the month of September was $0.00437 per kilowatt-hour and the service is very satisfactory.

THE FORCING CAPACITY OF MANNING BOILERS

SOME years ago Prof. J. E. Denton tested a vertical fire-tube boiler at the mill of the Bristol Mfg. Co., New Bedford, Mass., with the following principal results:

Commercial horsepower	194
Water heating surface per horsepower, sq. ft.	7.13
Dry coal burned sq. ft. of grate per hour, lb.	23
Dry coal burned sq. ft. of water heating surface per hr., lb.	0.47
Water evaporated per sq. ft. of water heating surface per hr. from and at 212 deg, lb.	4.83

This is not extreme forcing, but the results are quite surprising. For instance, the submerged length of the tubes was about 11 ft., and the evaporation was at the high rate of 4.83 lb. water from and at 212 deg. per square foot of water heating surface. The evaporation per pound of combustible was at the unusual rate of 12 lb. from and at 212 deg. This shows that vertical tubes are efficient absorbers of heat.

It is interesting to compare these results with those obtained in 2 remarkable tests of Manning boilers which were equipped with Roney stokers, made by F. W. Dean, at the mill of the Burgess Sulphite Fibre Co., Berlin, N. H.; of these one in which a draft of 1.28 in. of water was used is unique. The general results are given below:

	Test No. 1	Test No. 2
Force of draft in flue, in.	0.50	1.28
Commercial horsepower, hp	339	562
Water heating surface per horsepower sq. ft.	7.37	4.44
Dry coal burned per sq. ft. of grate per hour, lb	20.81	38.34
Dry coal burned per sq. ft. of grate water heating surface per hour, lb.	0.43	0.78
Water evaporated per sq. ft. of water heating surface per hour and at 212 deg., lb.	4.68	7.76

The results of test No. 1 are about the same as for the test at the Bristol Manufacturing Co.'s, but those on No. 2 are phenomenal. The economy is not good, but this is evidently due to the firing, as the carbon dioxide in the flue gases was low. Whether the firing could have been better, or whether the poor combustion was due to inexperience when forcing, Mr. Dean was frank in saying that he did not know.

The result 4.44 sq. ft. of water heating surface per horsepower is extremely small, and the coal consumption per square foot of grate, the coal burned per square foot of heating surface, and the water evaporated per square foot of heating surface are remarkably large. The percentage of power above the rating is no less noticeable. The temperature of the gases is low considering the coal consumed, although it would no doubt have been higher if the combustion had been better.

The Manning boiler has a very small water surface, and the ebullition during this test must have been tremendous. Nevertheless the steam left the boiler superheated 50 deg., that is to say, if moisture was in the steam as it escaped from the water surface, it was, by contact with the tubes, evaporated and superheated.

OVERHAULING ICE MACHINES

BY W. S. LUCKENBACH

AGAIN the time is at hand when the important question presents itself to both the owner and up-to-date engineer of ice machines how to increase the output during the next season at the least possible expense in the way of repairs, alterations and additions, or to maintain the same capacity at a less cost per ton in fuel and labor, regardless of the system by which it is operated. The following remarks, however, apply principally to the absorbtion system.

If the engineer has had thermometers installed at the various places, viz., one on the liquid ammonia pipe near the expansion valve, one between the expansion valve and the freezing tank, one on the absorber, one on the poor liquor pipe near the absorber, and one on the boiler feed pipe between the pump and the steam boiler and kept a record during the busy season as to the various temperatures, including cooling water and brine, he will have no trouble in locating the deficient part of the machine or any of its adjuncts, and any new parts coils or fittings that may be required should be ordered without delay so that when the machine is shut down for repairs there will be no delay in putting everything again in working order as speedily as possible.

Steam Boilers

First in importance as to the economical production of refrigeration is the steam boiler, and any attachment or alteration that will reduce the fuel consumption is money well invested provided that the cost is not excessive compared with the benefit derived therefrom. The boilers should be put in first class shape in every particular and in the writer's opinion, there is nothing more conducive to the economical production of steam than a boiler free from scale and other impurities; it is clear that if no impurities are pumped into the boiler there will be little precipitation or scale formation to diminish the units of heat absorbed by the water; therefore a first class combined heater and purifier is indispensable, and the thermometer between the boiler feeder and steam boiler will show at a glance whether the guaranteed temperature of the feed water passing through the heater and purifier is maintained, and if not, the remedy is apparent.

Purification of the feed water is of equal importance for 2 reasons; first, the purity of the ice and second, the sediment deposits. There are various methods of testing the water. Most natural water contains chlorides or sulphates and the addition of a few drops of a solution of nitrate of silver or chloride of barium to a sample of the water in a test tube or tumbler will cause a white turbidity or precipitate. It can readily be ascertained which chemical answers best by testing the raw water with each, to see which produces the most turbidity in it.

Water Pumps

Water pumps should be overhauled thoroughly, especially if steam driven. See that the water valves and plungers are tight in order to insure a full cylinder at every stroke, as the cost of operating the pump is about the same whether the cylinder is filled every stroke or only partially filled. The most economical way of driving the pumps is electrically, and next is by belt from a shaft to gearing. If the water is drawn from a well or stream, be sure that the check at the end of the suction pipe is in good condition; take no chances; attach a chain block and hoist it out of the water for a thorough examination, as it may save the engineer a whole lot of worry and some hard work, also loss of ice to the owner should it fail during the busy season.

Ammonia Pumps

Thoroughness advised in overhauling the water pumps will also apply to the ammonia pumps. It frequently happens that it is a hard matter to keep the pump from knocking, almost invariably caused by insufficient flow of rich liquor; by adding another suction pipe of the same area opposite the present one on the absorber, and enlarging the fittings at the pump to the area of both pipes it will insure a full flow to each side of the plunger and stop the noise. Another way is to enlarge the present suction pipe to double the area.

It is well to have a small connection from the poor liquor pipe somewhere near the absorber to the suction pipe, so that in case the pump gets gas bound it can be remedied by simply opening the valve for a few seconds to charge the pump, thus saving the possible necessity of stopping the pump, removing the valve caps and charging the pump in that way.

Generators

Generators should be opened and thoroughly examined internally; especially is this necessary where cast iron comes in contact with the hot aqua ammonia, as it is well known that cast iron deteriorates under such conditions. Should the tubes or coils be incrusted by reason of impurities in the aqua ammonia, they must be thoroughly cleaned, particularly if only exhaust steam is used, as this means a lower pressure and of course a lower temperature.

Careful hydrostatic test is next in order to insure against leaks as much as possible during the coming season and requires special care where only exhaust is used as the difference between the generator and exhaust steam pressure may be 6 to 1.

While it is essential, under all conditions, that the rich liquor enter the generator by first passing through an exchanger in order to increase its temperature, this is most important when liberating the gas from the aqua ammonia with heat from exhaust only. Yet the fact remains that some plants are operated by pumping direct from the absorber to the generator instead of passing the rich liquor through the inner tube of a double tube exchanger and the poor liquor through the outer tube in the opposite direction, thus imparting some of its excessive heat to the rich liquor before entering the generator and the poor liquor requiring less cooling water before entering the absorber.

This seems such a plain common sense and almost universally adopted method that the writer was surprised recently to find a large refrigerating plant operated without the use of an exchanger, viz., the rich liquor entering the generator at the absorber temperature. This plant is located in the power house of a large department store with restaurant attached. The engineer informed the writer that no ice was made, that it is principally intended for cold storage and cooling the filtered drinking water throughout the establishment, and I presume the reason that the discrepency is not apparent is because the steam heat used in the generators is the exhaust from the steam engines driving the many dynamos and other machinery.

Absorber

There is some difference of opinion as to the proper amount of liquor to carry in the absorber in order to absorb all the gas coming from the freezing tank coils, the proper amount however can be ascertained fairly well by testing the rich liquor passing through the ammonia pump at different heights in the absorber, as for instance, if the rich liquor indicates say 26 deg. at a certain height and 25 deg. at an additional height it is a sure indication that the limit has been reached, presuming there has been no other change, because the poor liquor coming over readily absorbs all the gas coming from the bath coils and fails to bring the rich liquor up to the standard; this of course is detrimental for 2 reasons, it requires more heat to extract the same percentage of gas from the 25-deg. aqua ammonia than from 26-deg. and is also an additional expense by reason of carrying that extra amount of aqua ammonia.

Adjuncts

While the following mentioned parts are not absolutely essential in operating an ice plant, they are entitled to careful consideration both from an economic standpoint and general comfort of the engineer; as for instance, an automatic poor liquor regulator attached to the absorber; this apparatus when once set requires scarcely any attention, thus enabling the engineer to pay more attention to other matters, and devise measures of economy throughout the plant. On the other hand, if the poor liquor entering the absorber is regulated by hand, he cannot leave the engine room with safety for any length of time because the amount of poor liquor entering the absorber varies with both the generator and absorber pressures.

A liquid ammonia receiver or collector with automatic water gage cocks is another device that commends itself to every engineer because he can at all times see the surplus he has, or whether he is drawing direct from the condensing coils, and right here is where an inserted thermometer plays an important part because the temperature of the liquid ammonia may sometimes be 5 deg. higher than usual without his being aware of it, as no one can detect a difference of 5 deg. by simply grasping the pipe, and the importance of knowing that the temperature has increased 5 deg. can easily be comprehended by referring to the standard table of properties of saturated ammonia and find that 1 cu. ft. of liquid ammonia at 70 deg. and 130 lb. pressure weighs 37.230 lb. and 1 cu. ft. of vapor or expanded gas weighs 0.4401 lb., thus expanding 84 times while at 75 deg. it expands only 77 times; hence, an increase of 5 deg. decreases the heat absorbing power of 1 cu. ft. of liquid ammonia, vaporized, 8.33 per cent.

It not only decreases its power to abstract heat from the brine but increases the temperature of the distilled water also; hence, it is clear that should the temperature of the liquid increase the brine temperature will increase if the engineer does not at once apply the remedy, viz., either the condensing coils need cleaning or more cooling water is needed. Neither will it then be necessary for him to chase all over the plant to find a reason for his brine having gone up a point or two.

A high and low water alarm is desirable in an ice making plant, especially the high water alarm where direct steam is used in the generators, because, should the water in the boiler get too high, the steam passing through the generator coils would be saturated and instead of all being condensed steam in the distilled water tank some would be simply boiled water and most likely would produce opaque ice which is a source of considerable annoyance to the engineer in tracing the cause. Therefore in case he hears the high water whistle and 42 or 48 hr. afterward finds opaque ice he will not need to give himself any concern as to the cause.

Renewals and Repairs

If, in testing the liquid ammonia at various times during the past season it was found to contain excessive moisture, and after examination it is found that there are no defects in the present rectifier, a dehydrator should be installed because a very small percentage of moisture reduces the capacity of the plant. It should be erected similar to that illustrated and described in the September, 1909, issue of Practical Engineer, page 538; at least that principle should be adhered to.

If the expansion coils in the freezing tank have not been examined for several seasons, it would be well to remove the brine, examine carefully all the coils, disconnect top and bottom manifold, clean the coils externally and see that there are no traps in the pipes; then blow them out with steam pressure, and if the weather is cold follow with air pressure to prevent any remaining condensation freezing. After they are all blown out and cleaned externally, test them with brine to not less than 250 lb. pressure, then allow them to drain, or blow out again with air pressure.

In reconnecting, be sure that the flanges are clean on the faces and use the best rubber obtainable.

Clean the threads on the flange bolts and cut down far enough to prevent the nut jamming on the body of the bolt; do not use old fittings on the ammonia system and wherever additional pipe is used, look into each piece for blisters; also see that the pipe cutter does not reduce the area of the pipe or leave ragged edges.

Have all the tank work done as expeditiously as possible in order to prevent the coils from rusting by reason of being exposed too long to the atmosphere.

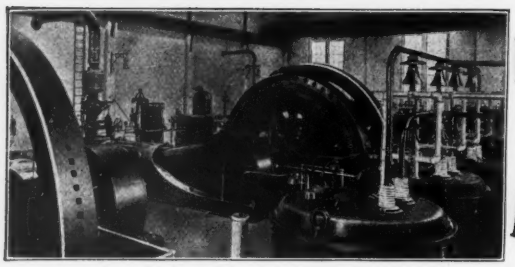
Have the bottom and sides of the bath lids cleaned, also the timbers that the lids rest on thus avoiding the dirt dropping in the cans to make bad butts in the ice.

Expansion coils in the brine tank should be in sections of 3 or more according to the size of the tank because by having the manifold or header in 1 continuous length, with outlets to the coils, and the expansion valve at 1 end it is a difficult matter to keep an even temperature over the entire bath unless each coil is regulated separately, as it is an established fact that all fluids, gases, etc., under pressure will when released, flow in a straight course unless diverted by meeting with resistance, which in this case would not happen until the last fitting was reached; hence there is bound to be more or less irregularity in the brine temperature, which will not be the case, if the coils are in sections, and a pipe leading from each section to a convenient location for the valves of all the sections so that they can easily be reached by the engineer. It is, however, well worth the extra cost to have a valve at both inlet and outlet of each coil.

General Appearance

While it is true that neither paint nor whitewash will make ice, yet the fact remains that a neatly kept engine room with tool racks and fittings bins lends cheerfulness to the place, and is more or less inspiring to all the help connected with the plant, and above all the cleanliness of the top of the freezing tank is not only a financial benefit to the owner by reason of cleaner ice but of special credit to the man in charge.

ELECTRICAL



MACHINERY AND APPARATUS

SYNCHRONOUS MOTORS

THEIR PROPERTIES AND OPERATION

BY F. M'NEILL

IN a recent article the writer referred to the incandescent lamp as being the nearest approach to a noninductive load for alternating-current circuits, with the possible exception of the synchronous motor. As this type of machine has peculiarities not inherent in the induction motor, a short explanation of its construction and application may be interesting.

Briefly stated, the synchronous motor is nothing more or less than an alternating-current generator, driven by electrical instead of mechanical means; just as any direct-current generator may be converted into a motor by making the proper external connections. Its fields are the same as the fields of any direct-current machine, and must be excited with direct current, which is usually supplied by a small direct-current generator, either belted or direct connected to it. This machine is called the exciter. Nearly all synchronous motors of recent make are of the revolving field type like the generators, but the old style revolving armature is just as efficient and works as satisfactorily, the only advantage of the former being that the collector rings have to carry the field current only.

Speed

The synchronous motor is so called on account of the fact that it must run in synchronism with the generator supplying it with power; not necessarily at the same speed, but some multiple of it. The speed is determined by the number of poles of the motor, and the frequency of the circuit to which it is connected. That is, the product of the speed and number of poles of the generator must be equal to that of speed and number of poles of the motor. If a generator having 30 poles were driven at a speed of 100 r. p. m., its frequency would be 3000 alternations a minute. A synchronous motor having but 4 poles connected to that generator would run 750 r. p. m. and a 2-pole machine would run 1500 r. p. m. In other words, the 2 machines run as if they were gear and pinion, and the fields were the teeth.

Means of Starting

Single-phase motors are not self-starting and have to be started by some external means, such as small induction motor, or the direct-current machine used as the exciter, may be used as a motor, if direct current is available for that purpose. Single-phase synchronous motors are seldom used on this account. Polyphase motors, however, are self-starting and will come to synchronism when started as induction motors; while they will not have as high starting torque as induction motors of the same size, they will start loads of 30 to 40 per cent of their capacity.

Starting up as an induction motor means to throw the line on the armature through a starting compensator or resistance of any kind, with the field open circuited. In practice, when there are many poles, it is not only necessary to open the field circuit, but the connections between the coils should be open in several places. This is on account of the high voltage that is induced in the coils by the armature reaction, and when all the coils are connected in series, as they are normally, they add their voltage together, so that a very high voltage is generated, which is liable to puncture the insulation. While the polyphase motor may be started as stated above, that method is seldom used on account of the enormous starting current required.

Synchronous motors are usually installed for driving loads that are constant, and in such places as will afford a method of starting, different from those mentioned above; also for another purpose than that of just doing the work required of them. This purpose will be explained later.

Connections of a System

The accompanying sketch shows the general wiring plan of a synchronous motor installation in which in the writer's estimation the best of methods are afforded for starting. The synchronous motor A is shown direct connected to a direct-current generator B. On the right of the figure at C is another direct-current generator, direct connected to a steam engine. The switches D, F, G, are the main switches for the machines A, B, C, respectively. E is the field switch for the synchronous motor; H is a regulation starting box, provided with a short circuiting switch K, and is connected in the line just as if generator B were a motor. R R′ R″ are the field rheostats of the machines, to which they are connected. I and J are synchronizing lamps and plug receptacles.

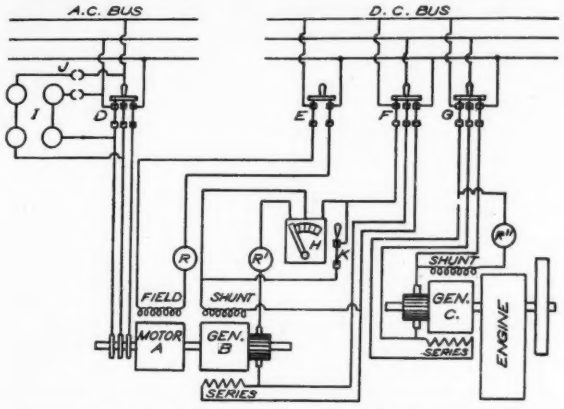
These machines are used for exciting the fields of several large alternating-current generators. The direct connected set A, B, being of ample capacity to do the work alone, the engine-driven generator is held in reserve in case of accident and for starting up.

Operation of Starting

To start an arrangement of this kind it is first necessary to start up the engine-driven set, then close switch G, all other switches being open. Next close switch F, after being sure that the starting box H is in

off position and short-circuiting switch K is open; also that all resistance is cut out of rheostat R, to insure maximum field strength. Generator B may now be started as a motor by slowly cutting resistance out of starting box H, and finally closing switch K.

The next operation is to connect the synchronous motor to the alternating-current bus bars. To do this, first close switch E, which will excite the fields of the synchronous motor, then adjust rheostat R until the voltage of the synchronous motor is equal to or slightly higher than that of the bus bars. Insert plug



WIRING PLAN OF A SYNCHRONOUS MOTOR INSTALLATION

in synchronizing receptacle J. The lamps I will now burn up to full brilliancy and go out again, changing very rapidly.

When the lamps are burning full the bus bars and synchronous machine are in direct opposition. When out, they are said to be in step or in synchronism. Should the changes be too rapid, the speed of the direct connected set should be regulated by means of the field rheostat R', until the e. m. f. generated by the motor is in perfect synchronism with the e. m. f. of the bus bars. In other words, until the lamps go out and stay out for a period of 2 or 3 seconds. When they are out, close switch D. By strengthening the field of generator B, that machine will take the load off generator E, when switch G may be opened and that set shut down.

Power Factor Regulation

The object in having a motor of this kind, when an induction motor could be used as well is on account of the fact that its power factor may be changed by adjusting the field strength; by overexciting, the current may be made to lead the e. m. f. instead of lagging behind, as it does with the induction motor. The advantage of this will be obvious, as the field may be adjusted to cause a leading current in right proportion to offset the lagging currents of other motors. For instance, if the power factor of an induction motor was 0.90 lagging, and a synchronous motor be connected to the same circuit, and its fields be overexcited until it has 0.90 power factor with a leading current, the average power factor of the total power supplied by the generator to these 2 motors would be 1.00. This is an important advantage that can be claimed for a synchronous motor installation, and even if the load is variable it will help for that purpose, as the power factor will be higher than with no synchronous motor on the system. To keep the factor at 1.00 the load has to be readjusted by hand with the field rheostat.

THE NEW WATSON-STILLMAN AUTOMATIC TANK SWITCH

This device is offered as a decided improvement over other switches for automatically maintaining the water level between desired limits in open tank or sump systems. The construction is novel, permitting the switch to be placed on top of the tank or sump cover, and permitting any desired variation in water level to be carried without relocating the electrical apparatus. When the switch is placed on top of the tank, as in this instance, there is no necessity for boring a hole into the side of the tank and there is no danger of the switch flooding and becoming short-circuited.

The operation of the Watson-Stillman switch in starting and stopping the motor is dependent upon the movement of a falling hammer, the movement of which in

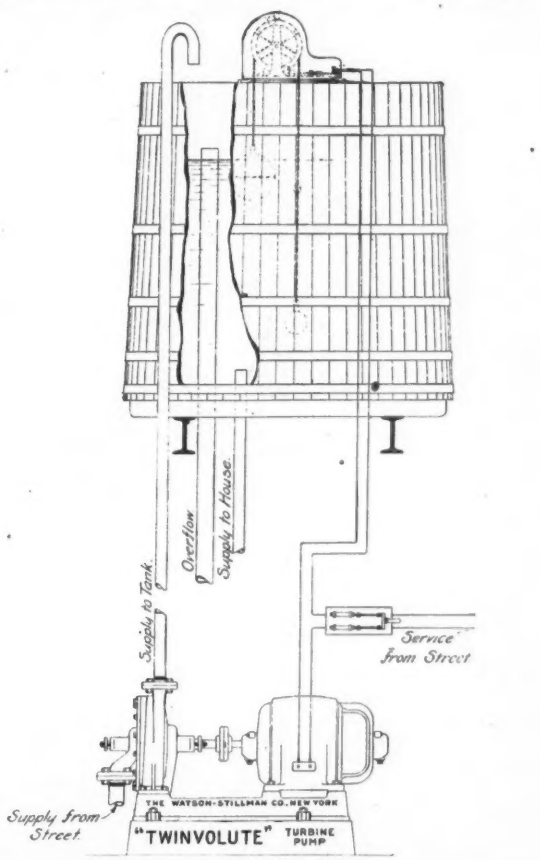


FIG. 1—ARRANGEMENT OF WATSON-STILLMAN AUTOMATIC SWITCH FOR WATER LEVEL CONTROL IN TANK

turn is governed by a freely suspended copper float nearly counterbalanced by a cast-iron ball. Referring to Fig. 1 which is shown arranged for tank service, the small wooden balls on the chain are adjustable and their position determines the variation of water level between operations of the pump.

In the interior view, Fig. 2, the switch is shown as when the pump is in operation. As the float rises, the ball A comes into contact with the projection P on the hammer and carries the hammer past the center. The hammer then falls to the other side of the pulley shaft by gravity, and in doing so, the lug L strikes a projection on the switch and disengages the knife, thus stopping the motor and pump. The switch movement is quick. There is no chance for arcing, and as the hammer remains

in contact with the switch arm, there can be no rebound. The hammer holds the switch arm in this postion until falling of the water level brings the other wooden ball B into contact with the hammer lug, which reverses the hammer, throws the knife into contact and starts the pump again. The wheel acts merely as a carrier for the copper chain. It plays no other part in the operation of the switch.

As arranged for draining sumps, the copper float and iron ball are reversed, which reverses the switch action to start the pump when the water level gets too high. Dampness will not affect the working qualities of the switch when it is placed in the pit.

The knife arm is thoroughly insulated from every other part of the switch and the two contact points are mounted upon a slate block. A suitable opening is provided in the body for inserting the tube and making the connection to the binding posts. No parts of the switch need oiling or other attention. The shaft is bronze to prevent corrosion and all parts are extra strong, all working parts being enclosed in a heavy cast-iron case which protects them from the weather and from sudden injury.

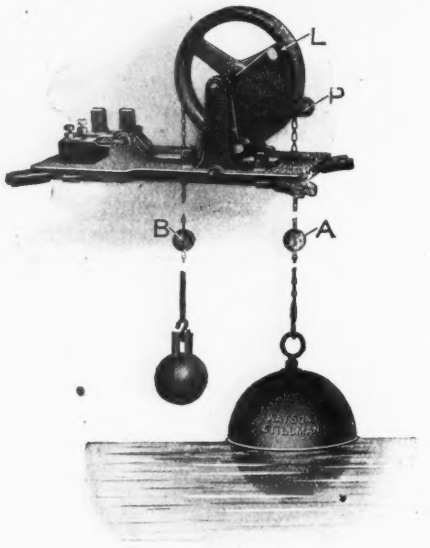


FIG. 2—INTERIOR VIEW OF AUTOMATIC SWITCH

This switch is made single or double pole and for all ordinary currents and voltages.

Sanding a Commutator

A good way to smooth a commutator is to take a piece of rubber or leather belting the width of the commutator and long enough to reach half way around it. Tack a cleat on each end of the belting so that you can bend it around the commutator. Place the sand paper underneath and hold firmly while the machine is in motion. Try this method and you will be pleased with the result. J. W. E.

Starting Box Connections

In the December issue of Practical Engineer Mr. Joseph Jacobs claims that diagram 1, page 736, is incorrect and should be connected as diagram 2, page 737. In part he says: "On moving the arm farther to the right we cut out armature resistance, but at the same time the field is being decreased because the field current has to flow through the armature resistance to reach the field coils, etc." I wish to say that diagram 1 is alright and is exactly as the manufacturers wire their starting boxes at the shop.

Starting boxes of this type are usually of less than 10 hp. Mr. Jacobs must take into consideration that the current taken by the fields is very small. In fact he will find that there will be practically no difference in the running of a motor, connected either way.

A starting box wired as diagram 2 is improper because the fields would always be fully excited whether the motor was running or not, so long as the switch is on, and it is desirable to avoid this. In diagram 1 this will not be the case, the fields being dead while the arm is on the first contact, as they should be.

In the larger starting boxes, 10 hp. and over, there is provided an extra contact which allows the current to go to fields without flowing through the armature resistance, as soon as the arm is moved over to the last contact. Paul E. Capraro.

I would say that to the best of my knowledge there is no danger or trouble if rheostat connections are made as in Fig. 1. The shop of which I have charge has 54 shunt motors, starting rheostats being furnished by Cutler & Hammer and they are all connected as in Fig. 1, and we have no trouble whatever because the armature resistance is strong enough to carry the field current without undue heating. I have never noticed any change in speed to amount to anything when motor is running under full load and no load.

One thing which is annoying is the flashing at the switch when a motor is stopped or when the switch is put in and pulled out without using any current when connected as Fig. 2. It is especially dangerous in shops or factories using volatile explosives. The flash is caused by the connection of the field to the line.

When rheostat connections are made as in Fig. 2 the flash which is made by pulling the switch without putting the arm onto the first contact is larger than if the arm was put onto the first or second or third contact button and the switch pulled when connected up as in Fig. 1. As I am fully convinced that there is no trouble when connected as in Fig. 1 I prefer that way and avoid the flash at the switch.

A ground on the line might help to make the flash greater and one would never be aware of the fact. The release magnet never refuses to hold the arm against the tension of the spring. Certainly the current is not great enough to blow up the armature, and it never blows the fuse nor slacks down when load is put on. Freibert Dreist.

IN ITS SUIT TO protect patents on the Sirocco centrifugal blower, the Sirocco Engineering Co., one of the constituent companies of which is the American Blower Co., has just received decision from Judge Hough, of the United States Circuit Court for the Southern District of New York. The decision in question was on the validity of the reissued patents for the Sirocco type of blower and is rendered in favor of the patents. It is recognized as not being a final judgment on all the questions arising in the suit, but only on this one point.

GEORGE M. BRILL AND HORACE C. GARDNER have formed a partnership under the name of Brill & Gardner for engineering practice in connection with constructive work on manufacturing and power plants. Mr. Brill has been engaged in this line of work for many years and Mr. Gardner has for over 20 yr. been manager of the construction and mechanical departments of Swift & Co.

A MODERN BOILER SHOP

NEW WORKS OF THE HEINE SAFETY BOILER CO., ST. LOUIS

DESIGN of a factory for building steam boilers and doing the kind of sheet metal work allied thereto is not as intricate a problem as that of other lines of manufacture. There were some interesting features, however, connected with the building of this recent plant that may be of service to others.

General Plan

The property on which the shop is located lies at the intersection of East Marcus avenue and the West Belt of the Terminal Railway, a double track main line. A trapezoid, one end being perpendicular to the sides, the other being at an angle of about 45 deg. The 4 sides are respectively, 259, 512, 771 and 836 ft.; an area of 6.5 acres.

The buildings as in Fig. 1, consist of a Main Shop, Flange Shop (which is a wing of the Main Shop), Power House, Toilet and Wash House, Oil House and General Office, totaling about 2.5 acres of floor space.

Handling Material

In general the raw material is received at the far end of the large building, that being the storage space. During the manufacturing processes it passes without reversal to the opposite end where the completed boilers are stored and shipped. Tubes, not being needed until boilers are assembled, are received and stored at this end. The whole floor area of both main and flange shops is served by large or small traveling cranes, while a 24-in. gage Koppel industrial railway completely encircles the structures with connections in the interior, so that the handling of material of all kinds may be carried on with the least expenditure of time and energy.

Of the main building, a portion of the interior is partitioned off for a machine shop to do the little work of that nature required in the manufacturing processes and to care for the ordinary repairs and maintenance of the plant.

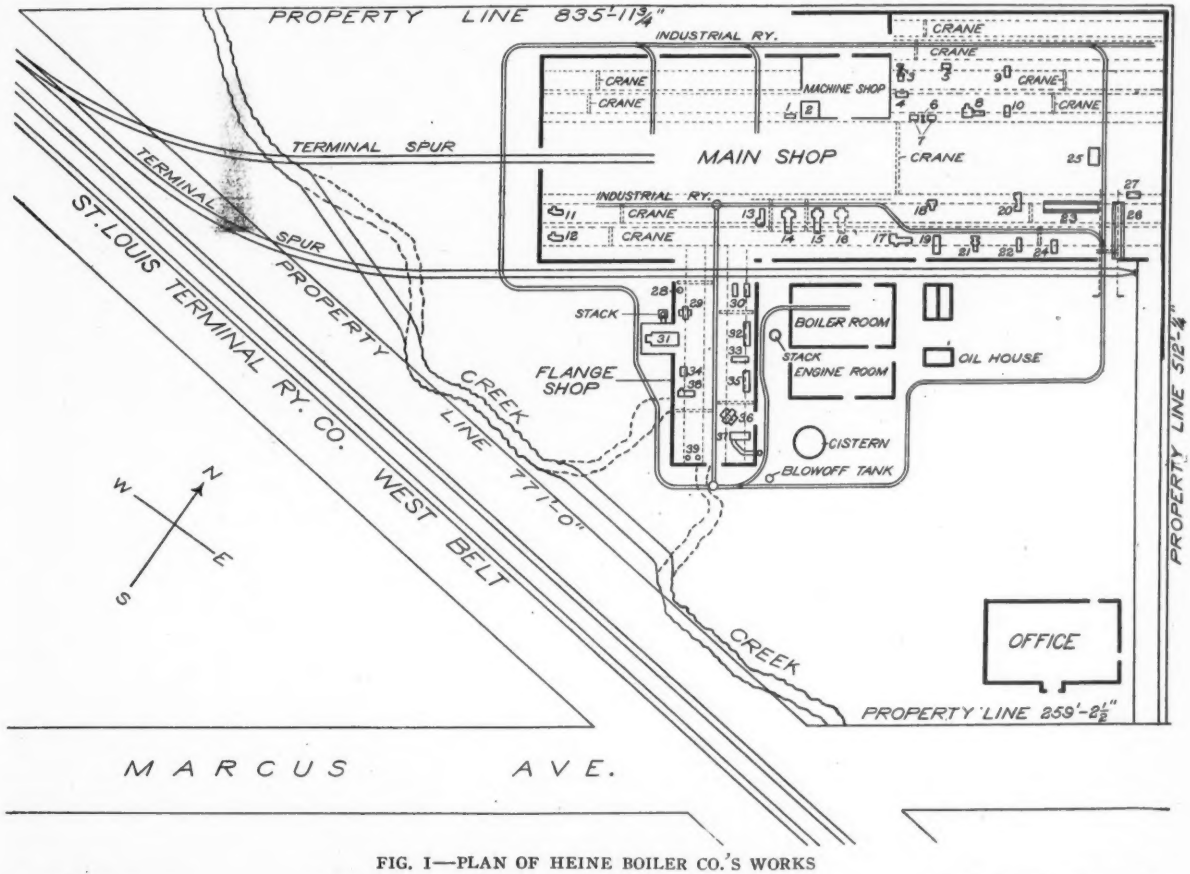


FIG. I—PLAN OF HEINE BOILER CO.'S WORKS

1. Grinding Machine.
2. Tool Room.
3. Motor Driving Bending Rolls.
4. 24-in. Punch.
5. Sheet Iron Brake.
6. 7.5 HP. Motor.
7. BA. Punch.
8. 8-ft.-2-in. Rolls, 10 HP.
9. 42-in. Splitting Shear, 7.5 HP.
10. 36-in. Punch, 7.5 HP.
11 and 12. Drill Presses, 10 HP., Motor Driven.
13. Horizontal Punch.
14 and 15. Triple-Power Hydraulic Riveters.
16. Future Riveter.
17. 14-ft.-2-in. Rolls, 2 Motors, 30 and 10 HP.
18. Bevel Shear, 7.5 HP.
19. 60-in. Punch and Shear.
20. 8-ft. Lennox Splitting Shear, 7.5 HP.
21. 36-in. E. F. Punch, 7.5 HP.
22. 36-in. Punch, 7.5 HP.
23. Rack for Waterleg Sheets.
24. 24-in. Punch, 7.5 HP.
25. Angle Bending Machine.
26. Rack for Shell Plates.
27. Friction Saw.
28. Forge.
29. 250-lb. Steam Hammer.
30. Punch and Shear, 60-in. Gap.
31. Plate Heating Furnace.
32. Forge.
33. Hydraulic Flanging Machine
34. Forge.
35. Forge.
36. 11,000-lb. Steam Hammer.
37. Forge Furnace.
38. Horizontal Punch.
39. Forges.

Power Supply

Three sources of power for the operation of the equipment are used, electric, hydraulic, and pneumatic. All the generating machinery is located in the

power house, which is placed in close proximity to the hydraulic and pneumatic tools, in order to reduce the length of the transmission lines, a saving both in first cost, frictional losses and maintenance. The great majority of the tools are electric driven, by individual Wagner motors wherever practicable.

Type of Building

All the several buildings are of the same general type. At the outset it was determined to eliminate the fire hazard, and to build durably, and yet have a maximum of natural light in the interior, which meant large window space. Steel frame structures with outside walls of brick, and reinforced concrete slab roofs were accordingly adopted, with full length monitors in the middle in order to obtain additional light and ventilation. About 75 per cent of the vertical areas exclusive of the retaining walls, are glass.

Main Shop

This building is 450 ft. long by 143 ft. wide for 250 ft. of its length and 180 ft. for the remaining 200 ft.

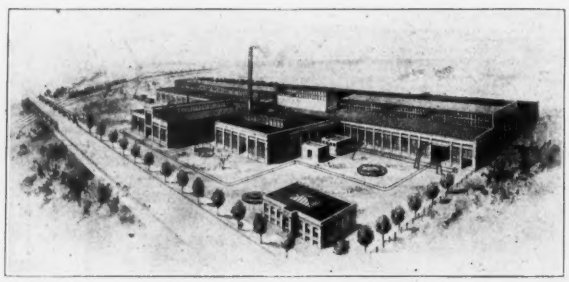


FIG. 2—BIRDS-EYE VIEW OF HEINE PLANT

It is of this latter part that the retaining walls form one side and end. The narrow portion is divided into three longitudinal bays, the middle one being 60 ft. wide and the two side ones 41.5 ft.

The outside walls are of brick with concrete footings and completely enclose the outer steel columns. The outside columns carrying the trusses of the fourth bay rest on the retaining wall, which also serves as a foundation for the brick walls that close the end and side of the building at these points. Practically all the windows in the walls are 9 ft. 8 inches wide by 17 ft. 5 in. in height, this being the standard size for all buildings.

Standard size of door opening is 9 ft. 8 in. by 12 ft. high, closed by 2 equal swinging doors, 1 of which contains a small door to permit employes to pass easily into and out of the building. In the receiving end is located a special door opening 22 ft. 2 in. wide by 20 ft. high, through which is carried a transverse crane way 18 ft. 8.25 in. span projecting outside of the building over the receiving track, the outer end being carried by A frames.

The roof is a 2.5-in. concrete slag reinforced with wire mesh and carried by 6-in. I beam purlins placed 5 ft. centers on top chords of the roof trusses. This is covered with 2-ply tar felt and gravel laid in hot asphalt.

The floor will ultimately be of cinders with a heavy residuum oil binder and compacted by rolling. At present it is the natural clay. As before stated the machine shop has a heavy plank floor.

Flange Shop

The shop is 62 ft. 4 in. wide by 144 ft. long, the construction being similar in every respect to that of the main building, to which it is connected, the end wall being omitted so that the two structures are practically one.

In one side of the building an opening is left in the wall for the large heating furnace which is housed in a small steel frame structure placed against and outside the wall.

One of the outer corners of the flange shop is over a fill and a part of the original creek bed, which made it necessary to carry concrete footings down 24 ft. to bed rock.

Power House

This building is 75 ft. wide by 79 ft. long. In general its construction is the same as that of the other 2 buildings, the main difference being that it is divided into an engine room, 34 ft. 7 in. wide, and boiler room 42 ft. 11 in. wide, by a brick wall in which is located a row of columns carrying the abutting ends of the

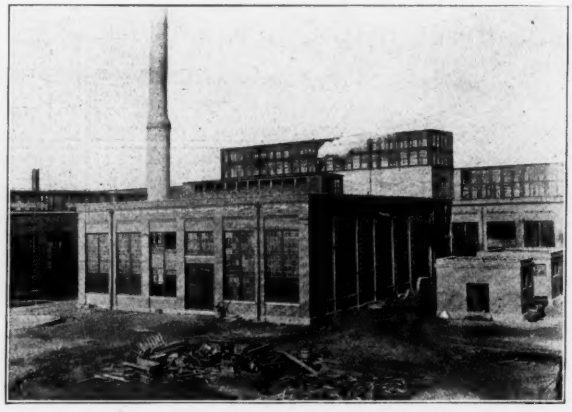


FIG. 3—HEINE POWER HOUSE

roof trusses. The monitor 13 ft. wide by 50 ft. long is half over one room and half over the other, the partition wall extending to its roof.

The middle row of columns and the outer row carry the runway of an overhead traveling crane serving the engine room. The roof is continued over the space between this and the main building in order that coal cars may be unloaded without interference by the weather. The entire floor of this building is at the same level made of concrete and provided with necessary pipe trenches, which are covered with iron plates.

The toilet and wash house is located 16 ft. 10 in. from the main shop and 20 ft. from the power house, where it is accessible with a minimum loss of time. It is a 1-story brick building 20 by 26 ft. with a concrete roof and floor and divided by a brick wall into toilet and wash rooms, all with white enamel fittings.

Equipment

In the main shop is stored all the raw material, supplies, etc., most of it at the extreme rear end and side where there is the least light, yet where it is accessible and easily removed to any point where it may be needed. In all shops a full outfit of cranes for handling material and tools, both standard and special, for forming up material is installed, the larger machines having individual motors. The machine shop equipment is mainly belt driven by a 20-hp. motor through a line shaft.

All the steam, hydraulic, and air pipes and electric wires are brought over from the power house in covered trenches, and are so arranged that they can be easily drained in cold weather to avoid all danger of

freezing. The air pipes have numerous connections at convenient points throughout the main shop, flange shop and machine shop.

Boiler Plant

This consists of 3 Heine boilers of 250 hp. each, set separately. Two of them are provided with Heine superheaters of 2 different capacities, and all are fired by hand and have flat shaking grates. Back of the bridge wall of each furnace is a special fire brick wing wall construction for the prevention of smoke and which accomplishes the object satisfactorily. The 2 boilers with the superheaters are set in brickwork in much the usual way.

The third boiler has a concrete setting with fire brick lining. This was tried as an experiment to determine the availability of concrete construction for this purpose, and with the expectation that it will be more durable than brick and less liable to the cracking to which all brick settings are subject. Each of the 3 boilers differs from the others in dimensions and all are arranged so that measurements and observations of all kinds may be conveniently made.

The company has in view a great variety of experiments to determine questions now in doubt and to develop further improvements in boiler practice. This will account for the boiler capacity being so greatly out of proportion to the rest of the plant, as one boiler will easily carry the load. A straight horizontal sheet-iron breeching connects the boilers with the chimney located in the space between the boiler house and the flange shop. This is a reinforced cement chimney 66 in. inside diameter by 147 ft. high, the foundation for which is 11 ft. deep and 22 ft. square at the base, a concrete monolith.

Coal is unloaded by hand into the space in front of the boilers, which has a capacity of about 2 cars.

Handling Feed Water

A Hoppes exhaust steam feed-water heater with a capacity of 15,000 lb. of water an hour is placed on an iron support against the division wall. Air supply for the compressor is brought from the roof through a 12-in. sheet-iron duct to an air washer placed behind the boilers. A small duplex steam pump delivers water from the cistern to the heater, being regulated by a Fisher governor. A boiler tester of the injector type supplies hot water under the required pressure for the hydrostatic test applied to all boilers before shipment. This testing can also be done by pressure from the hydraulic system, and through proper connections by the boiler feed pumps. An injector for feeding the boilers is provided for the use of the night watchman in order to avoid running the pumps.

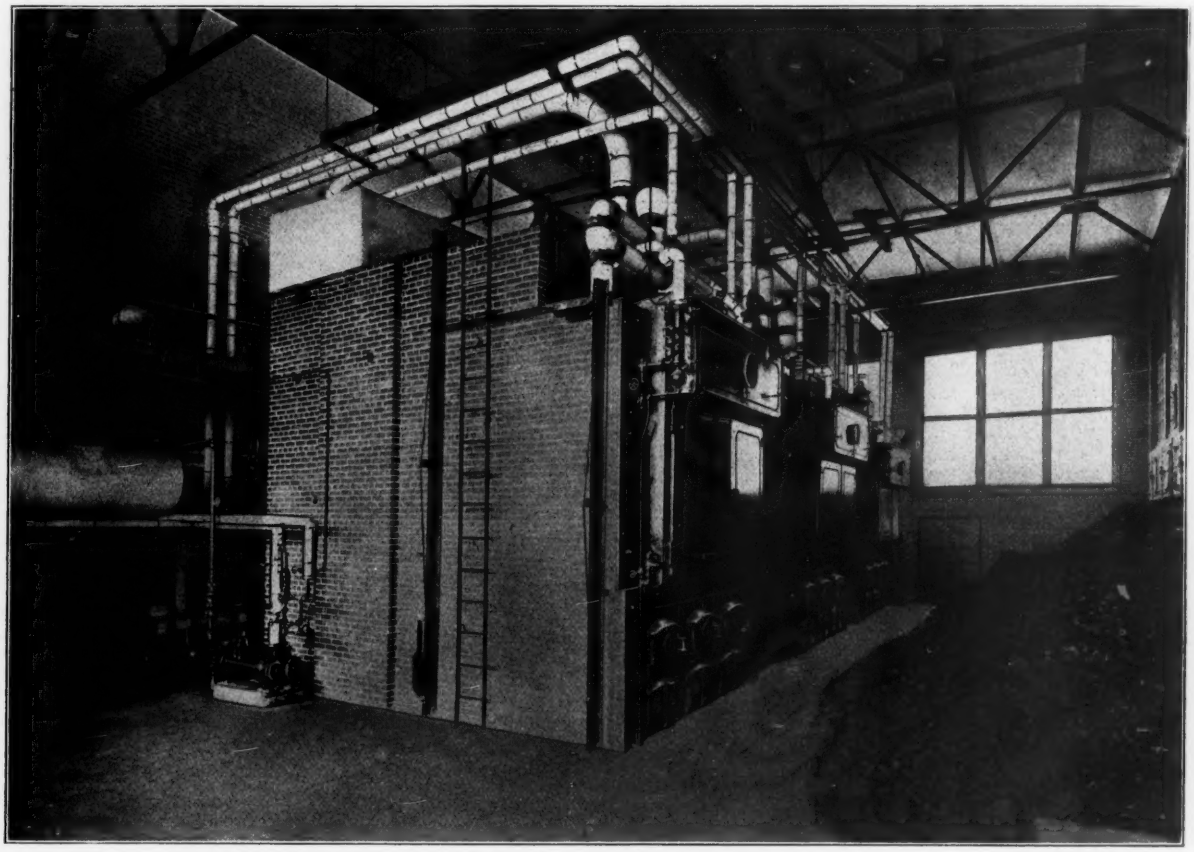


FIG. 4—BOILER ROOM EQUIPMENT

Two openings 3 ft. wide and 7 ft. high are the only inside communications between the boiler and engine room and are closed by sliding wooden doors covered with sheet iron. One end of the boiler room serves as a work shop and has an enclosed dressing room and toilet.

Generating Machinery

Electrical energy is developed by a 162-hp. 4-valve noncondensing Ball engine 13 by 18 in., running 200 r. p. m. A 100-kw. 220-volt 3-phase 60-cycle Western Electric Co.'s generator is directly connected to the engine, while a 10-kw. exciter is belted to a pulley on

the engine shaft. The voltage is maintained constant by a Tirrell regulator mounted on the switchboard. All wires in the engine room are placed in conduits under the floor. The switchboard is completely equipped with all needed measuring, controlling and distributing devices, and is divided into 4 panels; 1 for the generator, all current delivered being measured by a wattmeter; 2 for the 4 power circuits; 1 being for the 6 lighting circuits.

Air Compressors and Pumps

A Laidlaw-Dunn-Gordon 2-stage compound noncondensing air compressor is next to the engine. It has 12.5 and 22 in. steam and 22.5-in. and 14-in. air cylinders with 18 in. stroke. Its capacity is 1,200 cu. ft. of free air a minute at 100 lb. pressure when running at 145 r. p. m., 145 lb. steam pressure.

A Worthington duplex compound noncondensing pumping engine, with 14 in. and 22 in. diameter steam and 4 in. diameter water cylinders 18 in. stroke supplies the hydraulic system. Its capacity is 100 gal. a minute against 1,500 lb. pressure, with 145 lb. steam pressure. A Wood hydraulic accumulator, 12 in. diameter of ram and 15 ft. stroke loaded to give 1,500 lb. pressure per square inch is located in one corner of the room, and is connected with an automatic controlling valve which shuts off the pump when the limit of lift is reached.

A 700 cu. ft. Norwalk air compressor, an old machine from the old shop, is located next the larger machine, and is connected to the same supply and discharge, but is intended only for emergency use.

Two 7.5-in. by 4 in. by 6 in. Blake duplex outside packed plunger feed pumps are placed against the partition opposite the heater and are controlled by Fisher governors. The feed piping is in duplicate and so arranged that any boiler can be fed independently of the others and of the other pump. This is to permit the testing of any boiler without interfering in any way with the operation of the plant. The suctions of these pumps are connected to the heater, the city mains, and the cistern. Means are provided for filling boilers directly with city water. The small pumps have a separate steam header so as to be independent of the main steam header.

A 10-ton hand power traveling crane with 33.5 ft. span and 17.5 ft. lift serves the entire area of the engine room. Only the live steam pipes are exposed in this room, all others being laid in covered trenches.

Miscellaneous

Artificial lighting is mainly by 15 flaming arc lights uniformly distributed through the shops. They are hung to clear the cranes in monitor and bays and in the latter are about 22 ft. from the ground. The engine and boiler room have each one lamp of the same kind. Special 6-light incandescent fixtures are recessed in the walls 10 ft. from the floor around the sides of both engine and boiler rooms with switches in closed hand high pockets. The water and steam gages of the boilers each has a light on separate circuits for each boiler. No outside current is used for either lights or power, except for 2 arc lights for night use, and for the office.

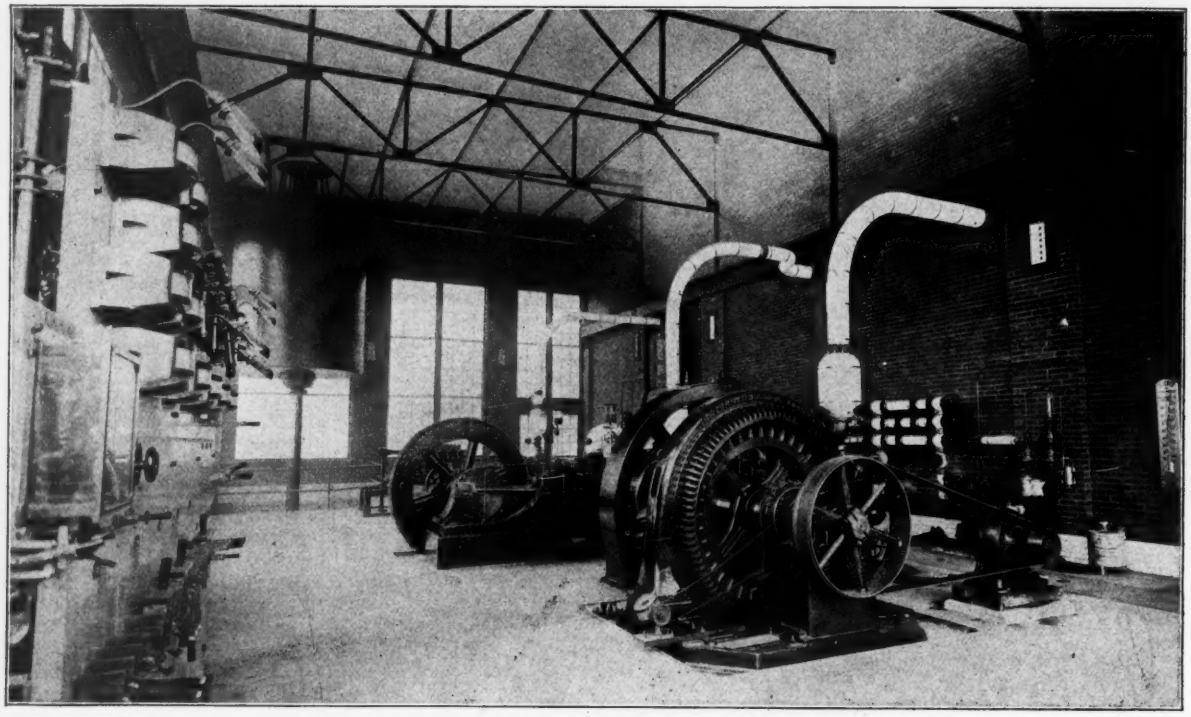


FIG. 5—ENGINE ROOM IN HEINE BOILER CO. PLANT

To provide cool drinking water in summer a special drinking fountain was designed, of which 2 are installed. This consists of a concrete lined pit about 4 by 6 by 3 ft., divided into 2 compartments, 1 27 by 27 in., the other 18 by 37 in. The walls of the larger, which is the ice chamber, are built with air spaces. Near the bottom is a horizontal coil of 1.25-in. galvanized pipe with a wooden grating above to hold the ice. A drain, the bottom of which is 2 in. above the top of the coil carries the warm water into the other compartment, in which are the valves for shutting off the supply, etc., and from which all waste is drained

into the drainage system leading to the cistern. Over this latter compartment is the hydrant, with a suitable waste pipe and perforated cover. About 300 lb. of ice can be put in the chamber which is covered with both a thick wooden and an iron lid. In hot weather the supply of ice lasts 2 days. Water from the city mains is used exclusively for drinking.

In grading, a little more than 18,000 cu. yd. of earth was excavated at a cost of 16c a yard.

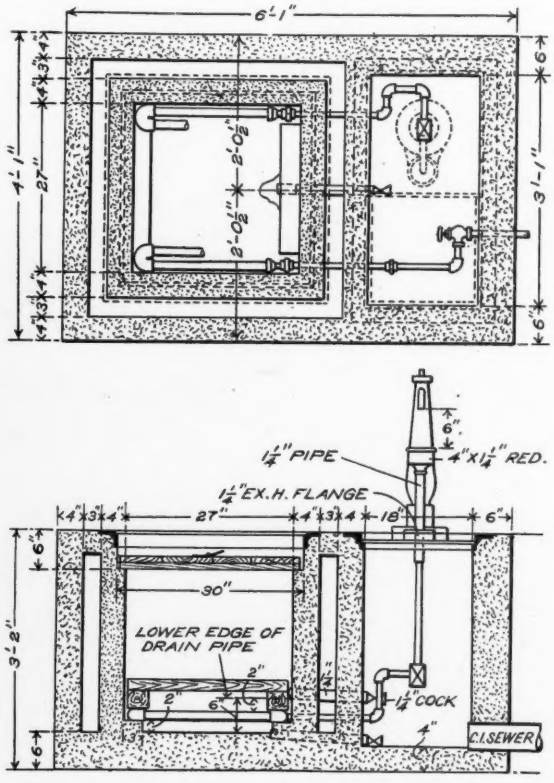


FIG. 6—PLAN AND SECTION OF CONCRETE DRINKING WATER COOLING TANKS

The steel work amounting to about 790 tons was furnished by the Riter Conley Mfg. Co. at the rate of practically 2.6c a lb. f. o. b. St. Louis, and was all inspected by the R. W. Hunt Bureau of Inspection and Tests before leaving the factory. The erecting of the steel was done at the rate of $8.80 a ton.

Total cost of these buildings was $1.15 a sq. ft. of floor area excluding the retaining walls and grading and $1.29 including those 2 items. This of course does not include any of the equipment.

IMPROVED VALVE GEAR

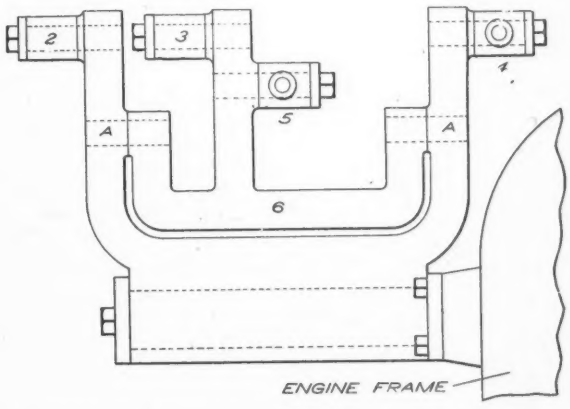
BY WILLIAM H. MAGEE

AMONG the improvements of recent years in valve gear for tandem compound engines are the rocker arm and attachments now in use by the Chandler and Taylor Co. of Indianapolis.

The accompanying sketch is a view from the back of the engine showing a post or rocker arm journal securely bolted to a pad provided on the frame casting; A is the main or high-pressure rocker arm which is under full control of a Rites governor; 2 is the eccentric-rod attached to the automatic eccentric strap; 3 is the eccentric rod attached to the strap of an eccentric secured to the shaft and having a fixed travel; 4 is the high-pressure valve rod; 5 the low-pressure valve rod and 6 is the low-pressure rocker arm which is a rocker within the main rocker arm.

It will readily be seen that this arrangement will give the low-pressure valve a combined motion from both the swinging eccentric and the rigid eccentric with a fixed travel. The eccentric rod 3 being connected to the fixed eccentric gives the top of rocker 6 a travel which is constant regardless of the changes in load, while the point of support at A A receives the effect of the motion of rocker arm 1 which is controlled by the governor.

This combined motion serves to keep the pressure in the receiver constant or nearly so in relation to the



ROCKER ARM GEAR FOR TANDEM COMPOUND ENGINE

initial pressure in the high-pressure cylinder, which, in turn, tends to equalize the amount of work done by the 2 cylinders.

By getting this effect, it is plain to be seen that the strain will tend to equalize on all parts of the engine which will produce smooth running and long life. On the whole, the receiver pressure being constant in its relation to the initial pressure in the high-pressure cylinder, brings the compound engine nearer to the desired object of its existence, to get the greatest amount of work out of the expansion of steam.

Some engine builders connect the high and low-pressure valves to the same eccentric placing both under full control of the governor with the result that the travel of both valves changes the same amount with every change of load causing a high receiver pressure on the light loads and making the high-pressure cylinder do most of the work on the heavy loads. Some other engine builders connect the high-pressure valve to the eccentric controlled by the governor and the low-pressure valve to a fixed eccentric which gives the high-pressure valve a variable cutoff and travel, while the travel of the low-pressure valve remains constant regardless of the change of load. This arrangement gives a high receiver pressure on the heavy loads causing the low-pressure cylinder to do the greater part of the work.

It will be noticed that, with the 2 mentioned arrangements, the valves must be set for a given load to obtain good results.

Change of receiver pressure causes rise and fall of temperature which produces condensation in the cylinders and receiver and winds up with a high cost at the coal pile.

HOW THE NEW CHIEF MADE GOOD

CO-OPERATION AND PLANNING MORE POWER

BY GEO. H. WALLACE

THE first winter which saw George Willard as chief engineer for Baum & Gautelbeim was most strenuous. Charlie Mather, the new superintendent, was beginning to get things well in hand and to establish a system of operation that eliminated shop waste and also carelessness and inefficiency among the men.

By his system of rearranging as much of the machinery as the belted system of power transmission would permit, he had not only increased production, but had decreased cost, and had done it with practically the same number of men.

No More Drudgery

During the incumbency of his predecessor, the factory had been run too much by the office, for John Gautelbeim had that grave fault so detrimental to success of wanting to "run" the whole works, and, not being able to pick the right man to run it for him. Thus it was that material was passed from floor to floor through trap doors or by stairways, necessitating much loss in needless handling, which is always wasteful.

After looking the matter over carefully for future development, Superintendent Mather installed a few large freight elevators of such size as would accommodate truck loads of lumber. These elevators were placed where they would be convenient in the new factory building which he proposed to build outside of the old one in the near future. They were bricked in with steel doors and would not be affected by any changes in the several buildings. Each was operated by a 240-volt direct-current motor, current for which was furnished by a 25-kw. direct connected unit, which Gautelbeim bought for the chief with considerable reluctance.

Willard had in mind that this would furnish about the right amount of lights for night service in the new power house at some future date.

With a great deal of the drudgery of excessive manual labor thus removed, the employes began to see that there was something more in life than hard work and payday, and on every side were heard expressions favorable to the new superintendent and chief engineer.

The Glad Hand

Tuesday before Thanksgiving the following notice was posted on the bulletin boards about the shop:

NOTICE

On Dec. 1 there will be a general advance in wages in all departments of this plant, that will affect all employes who have been on the payroll 1 year or longer.

Those having been employed 1 year will receive an advance of 5 per cent.

Those having been employed 2 years continuously will receive an advance of 10 per cent.

Those having been employed 4 years continuously will receive an advance of 15 per cent.

Each married man will receive a Thanksgiving turkey at the time-keeper's office on Wednesday evening at the close of work.

Each single man will receive $1.

We sincerely hope that each employe will spend Thanksgiving day pleasantly and happily.

(signed) Baum & Gaultelbeim,
Per C. J. Mather, Supt.

There was but one effect that such a notice could produce. The men took a keener interest in their work than had ever been done before. They felt that their efforts were appreciated, felt that there was sunshine in their lives and not the gloom of everlasting drudgery.

A few, of course, felt their importance and said "what's the use of workin' any harder? We get the coin anyway." These were speedily weeded out as "undesirable citizens," and this action was universally approved by those who remained.

New Rules

Under the former disorganized management, the shop had been literally papered with the most stringent rules and orders and it was noted that commitment of the numerous offences or violations of rules would be followed by instant discharge.

Mather had all these removed. The removal brought on a heated interview with the general manager but his "bark" was fast losing its significance and he was shouldered to one side. The new rules that were posted in their place were conspicuous by their simplicity, broadness, and fairness:

Shop Rules

"No man will be discharged for making a mistake once.

"Any man will be discharged for concealing one or making the same one twice.

"We will give our employes a square deal and expect the same from them in return."

B. & G.,
C. J. Mather, Supt.

These brief rules were taken in the spirit in which they were meant and the quality of the work picked up immensely while the output improved. The employes felt once more that they were free Americans and not galley slaves condemned for life to be chained to the gunwale of the king's galley.

One day the superintendent strolled into the little office of the chief engineer and found Willard very busy over a drawing table. They greeted each other pleasantly.

"Well, Willard, what are you doing there? Making your will?" asked the superintendent, as he examined the sketch over the chief's shoulder, and then exclaimed, "Well, well, well, if she isn't a new power house! Say, Willard, when do you start to dig the cellar?"

"When? Well, that depends on people and circumstances," said Willard, thinking of the manager. "But this is what I think we ought to have. It's just a preliminary sketch, however. I am working out the details in a general way and when I get at something definite, we will call upon the Board of Directors."

"How are the old engines holding out?" asked Mather.

"Something better than the boilers are holding in,"

replied Willard. "I have cut the pressure on every one of the old boilers in the plant, not because they were old—that ought not to be a good reason—but simply because the thickness of metal was not there to make them reasonably safe. Now since you are pushing me a little for power, it's about time to get in our new equipment. That special poppet valve governor which we put on the 15 x 27 engine is certainly a good contrivance," and he drew a bunch of indicator cards from his desk and selected the 3 shown in the illustrations.

"Here," he continued, "is the double card taken with the old throttling governor, and the next two are typical head and crank end cards taken after we put on the poppet valve governor. Mr. Mather, that's where you got the money to buy those Thanksgiving turkeys right off those last 2 cards and while they are not as economical as a Corliss card, yet in our new power plant we will get enough more out of the steam to buy a few more turkeys."

"Yes," replied the superintendent, "and the raise in wages for the men came out of those new-fangled valves you put on the other old engines."

"Well, be that as it may," said Willard. "Right now we are indicating about 30 to 35 per cent more horsepower than we were last summer when I came

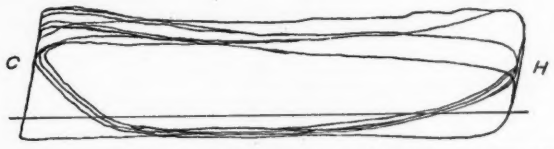


FIG. 1—DIAGRAMS FROM THE THROTTLING GOVERNOR WITH ARC INDICATOR, SPRING 40 LB., PRESSURE 80 LB., R. P. M. 55.

here and we are doing it for about 60 to 65 per cent of what it cost for fuel then. Those shavings, and edgings which our esteemed employer formerly threw into the river, or let the rising generation steal without even going through the formality of asking for them, make good steam, and the longer they last, the less coal it takes to finish the run."

"Willard," said Mather with deliberation, "I want to tell you something. If it weren't for the great reduction in the cost of producing power, other things about the factory could not have been attempted. This end of the plant is where the saving began and the honor is all yours."

"Now see here Mather," said Williard, as he put up his hand to ward off the compliments. "I don't like all this grandstand speech business of yours. The honor and glory belong to you, every bit of it. You hired me, and if my efforts so far have proved to be of benefit all around, I am satisfied that the final result is to the good. No, Mather, the honor is all yours."

"Well," replied Mather, "if you will not accept the honor that is yours, I do not think that you will refuse $25 a month more pay, will you?"

For the first time since Willard became chief engineer he was at a loss for words to meet the situation. Finally he pulled himself together and said "Thank you."

"But how far along have you gotten with your sketch for the new power house?" said Mather.

"Well, it is just roughed out at present," said Willard. "I have arranged it in a general way as to the makeup, but the details as to piping and location of the auxiliaries, etc., will have to be worked out later."

Mather examined the sketch carefully for a few minutes, making a few inquiries now and then and finally asked:

"When will you be in a position to show John Gautelbeim?"

"Right now if you say so," and suiting the action to the word, he removed the thumb tacks, rolled up his sketch, and followed by the superintendent left the engine room.

"Now," soliloquized Fritz, the engineer, "you choost votch oudt for some more fireworks if dey go

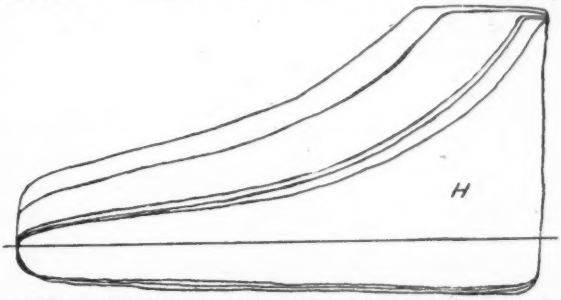


FIG. 2—HEAD END CARD WITH POPPET VALVE CUTOFF GOVERNOR. SPRING 30 LB., STEAM 65 LB., R. P. M. 60, VACUUM 23 IN.

ofer to see der oldt mans. By chimminy, I bets he schlog Misser Villard on der kopf von, two, tree, times yet!" and he chuckled inwardly as he swept the passing crankpin with the backs of his fingers in passing out to the boiler room.

As Willard and Mather approached the office the front door opened and down the steps tripped a dashing young lady, leaving Willard with a vision of

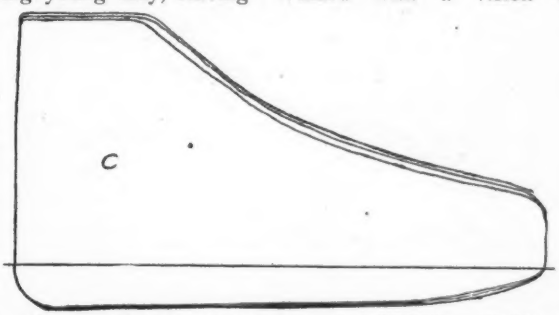


FIG. 3—CRANK END CARD WITH GOVERNOR. SPRING 30 LB., STEAM 67 LB., R. P. M. 60, VACUUM 22 IN.

stunning clothes, beautiful features and graceful movement. She skipped across the walk and into the commodious Cadillard-Dart and as the chaffeur guided the noiseless car skillfully up the street, Willard spoke: "Say, Mr. Mather, who was that beautiful young woman?"

"That? Oh, that was Miss Dorothy, the old man's only daughter."

Until the car had passed from view the chief engineer watched it. Mr. Mather, being already possessed of a woman whom he believed was "the best on any earth," had passed through the heart throb stage several years before and recognized the symptoms. But there comes a time when patience ceases to be a virtue and he startled the chief by exclaiming, "Come, Willard, let's go up and see Gautelbeim about the new power house," and together they entered the lion's den.

THE STATIONARY ENGINEERS' CLUB of Philadelphia meets every Wednesday evening at 1108 Arch Street, and has elected the following officers: President, Jos. T. Amons; vice president, Oliver Kase; financial and corresponding secretary, J. J. Devine.

THE TOMLINSON BAROMETRIC CONDENSER

Although condensers have been in use in connection with steam engines ever since the first engine was put into commercial operation, it has been only in recent years that their efficiency and economy have been developed to a degree that engineers have considered them necessary adjuncts to the compound engine. In Fig. 1 is illustrated the Tomlinson Type AN barometric condenser installed for use in an elevator plant, showing clearly the method of connecting up the apparatus and the ease with which it may be applied to any similar installation.

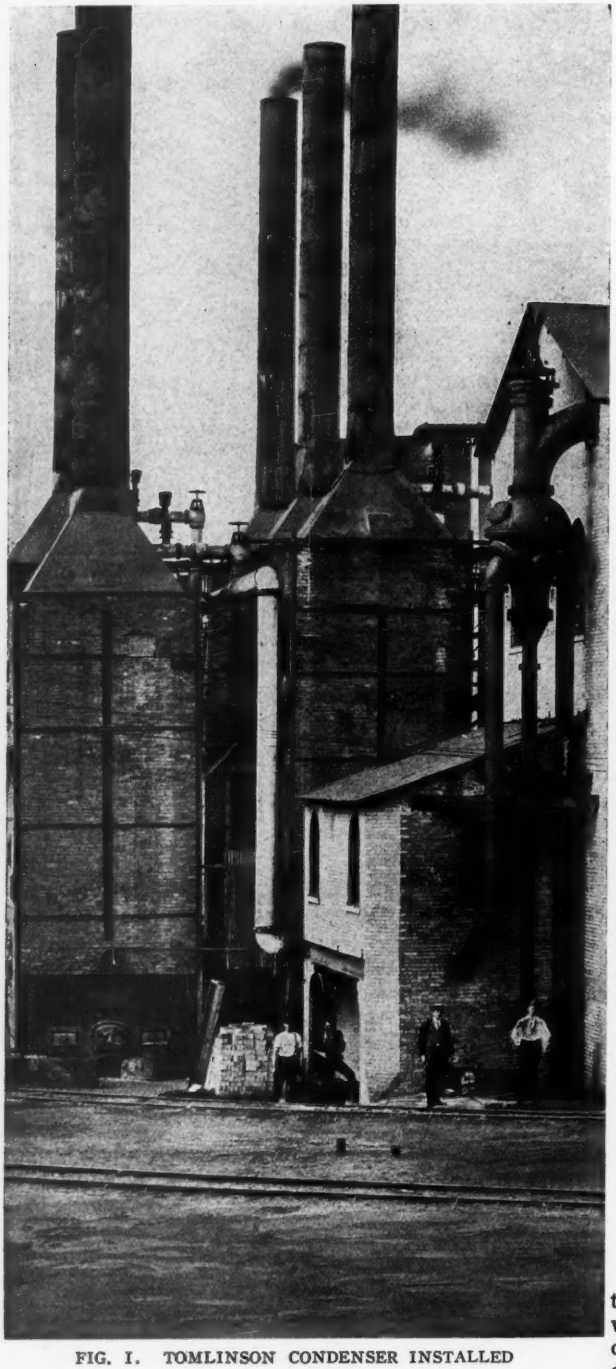


FIG. 1. TOMLINSON CONDENSER INSTALLED

By reference to the sectional drawing of this condenser, it will be seen that the steam enters the condenser at the top; the water enters at the side and flows over the top and down into the steam and condensed-water combining chamber where the steam is condensed and carried with the injection water down through the contracted throat and tail pipe to the hot well. The top of the water and the steam combining chamber is made with the serrated form in order to divide the water, so that a portion of the steam will flow through the opening behind the hollow column of water. With this arrangement, the water and steam will mix more thoroughly than would be possible if the steam came in contact with the inside surface only of the hollow column of water.

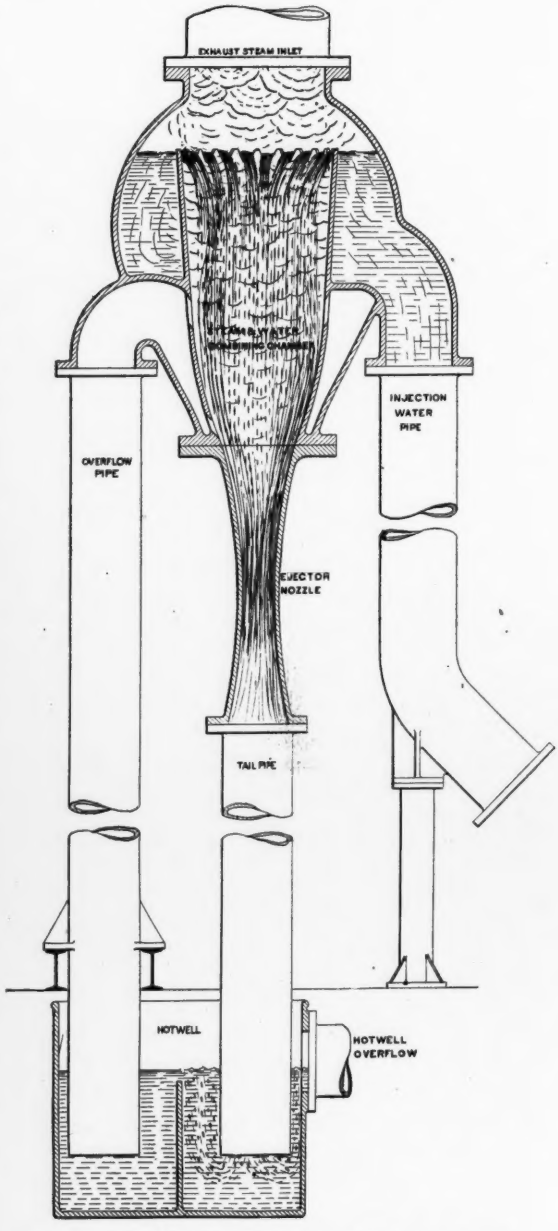


FIG. 2. SECTIONAL VIEW OF TYPE AN CONDENSER

The water and air combining chamber is provided

with slots through the sides which communicate with the chamber surrounding it, and to this chamber is attached an overflow pipe, and the end of it is sealed in the hot well. The object of this portion of the condenser is to take care of a possible flooding of the combining chamber, which has resulted in so many disastrous engine wrecks, where condensers were used which were not provided with means of taking care of more water than would flow down the tail pipe.

The construction of this condenser is such that no dry air pump is required, as the air is forced out of the condenser partially by the energy of the steam which is flowing in at a high velocity and partially by the tendency of the air to cling to the sides of the falling water. The hot well has a partition between the center tail pipe and overflow pipe to prevent the air which comes down the center pipe from returning through the overflow pipe to the condenser.

This condenser is manufactured by the Allis-Chalmers Co. and carries with it the guarantee of excellent service, which is typical of all that company's apparatus.

THE NEW BROWNELL ENGINE

AMONG the designs embodying the latest thought and many novel ideas in engine construction is the new engine, which is illustrated herewith, made by Brownell & Co., Dayton, O. It is difficult to know with just what excellent feature to begin in a description of this machine. It is built in types for which modern service makes demand, tandem compound or simple. The view shown is that of a tandem engine, direct connected type and illustrates clearly the pleasing and strong design of the frame, base and extension bed.

It will be noted that the frame, symmetrical in design and of pleasing outline, has been so arranged that there is plenty of metal distributed in the line of the bearings so that its strain is evenly distributed; the reciprocating parts and crankpin are easily accessible; the floor space is the least possible and the shaft and crank can be made much more durable than with any other design. Economy is also increased because of the reduced friction due to the distribution of weight of generator and pull of belt on 2 bearings instead of one.

Economy

Broadly speaking, the economy of an engine includes not only the amount of steam used per horsepower hour but the cost of repairs, the cost of floor space, the interest and depreciation on investment required and the expense of care in operation. All these

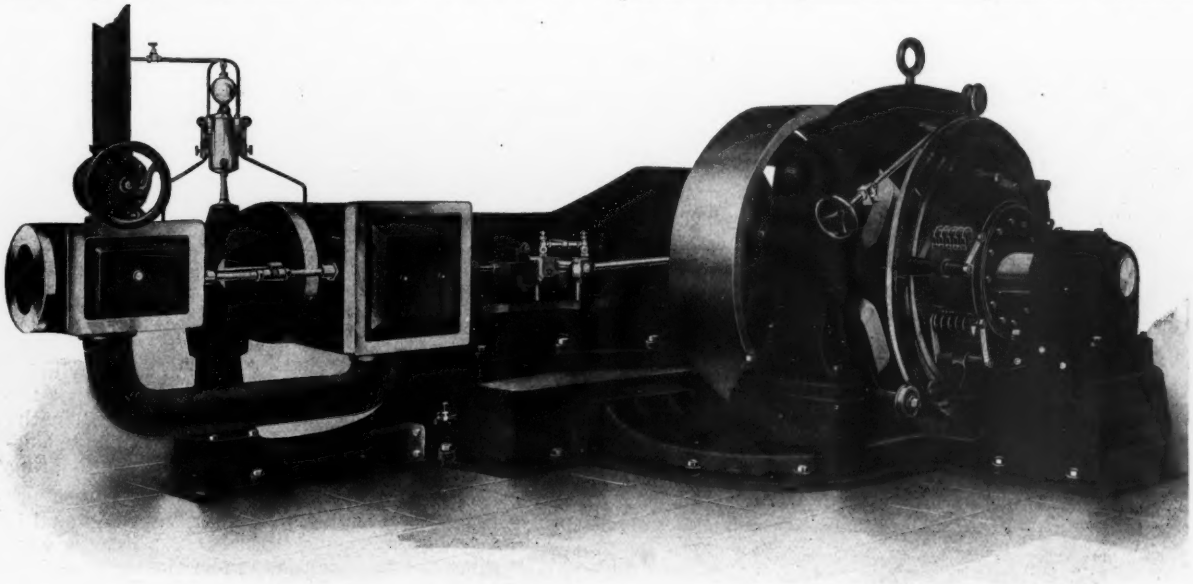


FIG. I—DIRECT CONNECTED TYPE BROWNELL AUTOMATIC SIDE CRANK ENGINE

strains, so that rigidity is secured, keeping the bearings in line under all conditions, and the engine has been enclosed to prevent throwing of oil, while having covers which give ready access to all parts for inspection.

Of Side Crank Pattern

This design has been chosen because the builders from experience have determined it to be the best. Alinement of the crank and shaft is absolutely necessary for good performance, and this design permits of easy maintenance of such alinement.

In the belted machine the pulley is placed between

points have been taken into consideration in choosing the type of the Brownell engine and elaborating its design. The high-speed, single-valve type admits of high rotative speeds without excessively high piston speed, gives small floor space, few parts to be kept in adjustment, low cylinder condensation and a low first cost. Clearance can also be made small because the steam ports are short and direct and the ample lubrication keeps the friction low.

Turning to the details, the entire operation of an engine is controlled by the governor and this is perhaps the most important department in the organization of the machine.

The Governor

On the Brownell engine the Rites inertia type is used and in general design needs no special description. It operates utilizing both centrifugal and inertia forces to take care respectively of gradual and sudden changes in the load.

Friction in a governor is the arch fiend which makes most of the trouble, and in the Brownell design a single weighted arm swings on a pivot pin which has a bronze bushing with ample provision for lubrication, thus giving the best possible insurance against difficulty. Attached to this weighted arm, as shown in Fig. 2, is the eccentric which drives the valve. This eccentric is made in 2 parts, as shown in Fig. 4, and has surrounding it a 2-part eccentric strap, the part which attaches to the eccentric rod being provided with an oil well. The swing of the governor arm carries the center of the eccentric nearer to or farther from the shaft center, so that the travel of the valve is changed, controlling the admission of steam with changes in load.

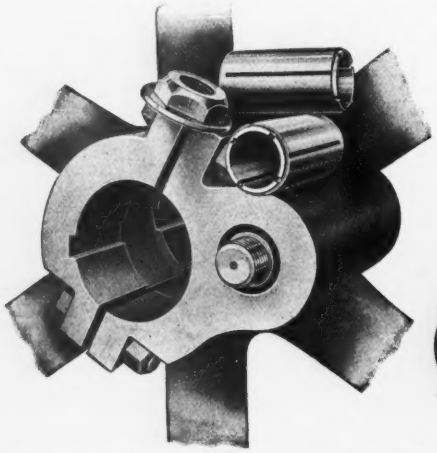


FIG. 3—BRONZE GOVERNOR PIN BUSHING

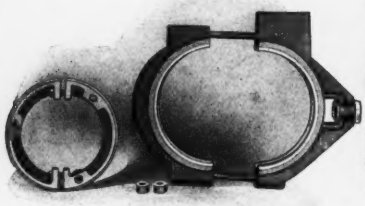


FIG. 4—ECCENTRIC AND STRAP

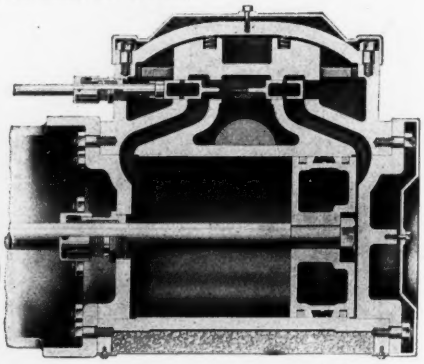


FIG. 5—SECTION OF CYLINDER AND VALVE OF BROWNELL ENGINE

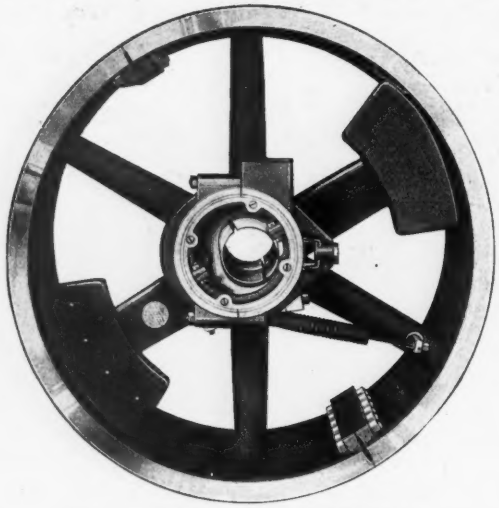


FIG. 2—BROWNELL-RITES GOVERNOR

The Valve

Driven from the eccentric is a flat balanced valve, shown in the cross section of steam chest and cylinder, Fig. 5. Quick opening is secured by the multiported construction, and by the use of the hollow valve lightness with strength is provided. Openings through the valve and the pressure plate kept against the top of the valve by springs bearing on the steam chest cover give the balanced effect which must be had to avoid friction and thus permit a long valve, which gives short ports and small clearance.

The valve stands vertical when running, as shown in Fig. 6, so that it takes up its own wear. Overrunning the valve seat insures against any wearing of ridges, either on valve or seat, and the flat surfaces are of such form as to be easily refinished whenever necessary. The spring bearing of the pressure plate against the steam chest cover provides also means for relieving the cylinder in case of water.

This valve construction is not a cheap one; cheapness has not been the end sought by the builders of the Brownell engine, but they have chosen the design which seemed to offer the greatest advantages, believing that these advantages justify the increased cost.

Cylinders and Pistons

In arrangement of the cylinders the form is adopted of placing the high-pressure cylinder outside. This gives a less weight to support than in the reverse arrangement and this weight is carried by an extension on the end of the frame and a pedestal. The cylinder is bolted direct to the frame, so that the end of the frame forms the crank end cylinder head and in the compound type cylinders and distance pieces are bolted together with a metal to metal joint, thus insuring perfect alinement at all times.

A single casting, cored so that the outside metal is thin to give lightness, and braced with ribs to give it strength, is used as a piston, and in the smaller sizes is pressed on the rod with the rod riveted over, while in the larger sizes it is pressed on the rod and held in place by a nut. For the tandem compound design the piston head is screwed on the rod and held in position by a nut so as to be easily removed. Two packing rings are used on each piston, of the standard cast-iron snap type, and a ring of antifriction metal is placed in the center to take the wear.

Crosshead and Connecting Rod

Bronze shoes, cast solid and made adjustable by means of bolts and check nuts at the end, are used on the crosshead, giving an instantaneous method of adjustment. The piston rod is as usual for such construction, screwed into the crosshead and locked by a nut, while the connecting rod connection is made to a crosshead pin which is held in position by a lock nut

on the end and can be turned in position to adjust for wear.

Both ends of the connecting rod are solid, with mortises cut to receive the boxes, and adjustment by wedges. Both boxes move in the same direction to take up wear, so that the length of the rod between centers is not changed. At the crosshead end the boxes are of bronze and at the crank end babbitt lined. The crosshead is turned to fit bored guides and will, therefore, take the position needed to adjust itself to the crankpin.

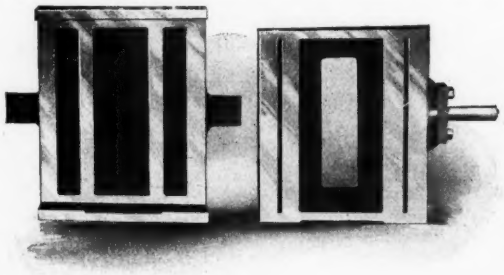


FIG. 6—VALVE AND PRESSUBE PLATE.

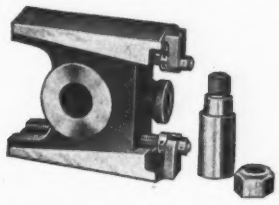


FIG. 7—CROSSHEAD WITH BRONZE SHOES AND PIN

sary to insure perfect alinement. It is lubricated by chains dipping into an oil reservoir and is kept in adjustment for wear of the bearing by means of metal liners inserted between the halves of the box.

Rigidity of the entire structure and reduced cost of foundation are secured by the use of a sub-base to which the extension for the cylinder pedestal and the extension base for the generator in direct connected units are bolted. In the case of tandem compound engines, the pedestal is used under the distance piece between the cylinders and in the case of simple engines under the rear end of the cylinder.

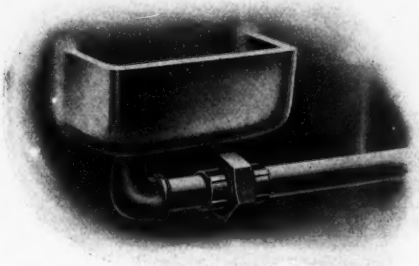


FIG. 8—RESERVOIR FOR OIL TO VALVE ROD GUIDES

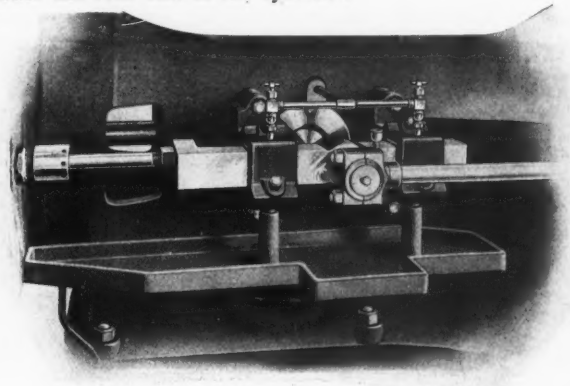


FIG. 9—SIGHT-FEED OIL SUPPLY TO VALVE ROD GUIDES

Lubrication

For engines which run at high rotative speeds, automatic or self-lubrication is a necessity, and the special features adopted on the Brownell are such as to insure cleanliness, with smooth and quiet operation and no possibility of lubrication failing. Under the crank is an oil well which is filled so that the circumference of the crank disk is in contact with the oil. Centrifugal force, therefore, throws great quantities of the oil back upon the guides and crosshead and into small reservoirs in the hood and engine frame.

From these reservoirs the oil supply is carried to main bearing, eccentric and guides by means of short tubes, and from these bearings it goes back to the main reservoir by gravity. By using these reservoirs the flow of oil to the bearings is always visible to the engineer.

As typical of the method of oiling, Fig. 8 shows the reservoir on the inside of the frame which catches oil for the valve rods, and 9 the sight feed by which the oil is carried to the valve rod guides. The supply of oil for the main bearings is caught in a similar reservoir in the oil hood which covers the crank disk and is carried by a short pipe through a sight feed oiler to the main bearing cap.

The outboard bearing is supplied with adjustable sole plate and wedges so that it can be quickly raised or lowered or moved to either side, as may be neces-

Testing Out

In erection and testing of the engines the builders are as particular as in design and manufacture. All

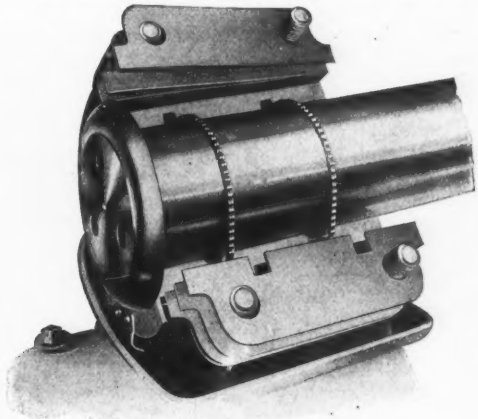


FIG. 10—OUTBOARD BEARING OPEN TO SHOW CHAINS AND LINERS

engines are erected in the shop and carefully tested under steam with brake and indicator, to make certain that adjustments are all correct and that speed and regulation are as desired.

REMINISCENCES OF AN ERECTING ENGINEER

LINING THE ENGINE

BY M. E. P.

IN THIS chapter we shall have to do with the work that is of the most importance in the erection of an engine and I shall try and make every step clear as possible. The utmost care should be exercised in lining an engine and every thing about it should be minutely looked to so that when the work is finished every one of the measurements will be perfect. If this is done we may be sure that the engine will run well and quietly and will require little repair work in future.

A Careless Job

I was once sent out on a job with 2 engines to erect and a man from the shop was sent along to help me and look after 1 of them. He went ahead with the placing of parts all right, set his lines and got lined up to his satisfaction and told me that he was ready to cement the engine. I thought I would check his lines and on doing so found that his low-pressure crank was out about 1/32 in. The engine had a 48-in. stroke and was rather long framed.

When I called his attention to the error he said that he did not think that so small an amount would make any difference in an engine of that size and argued that the expansion of the shaft and frame would make more difference than that when the engine got hot. Now he was right about that in a certain way, but he could not tell just where things were going to give and just how much expansion there would be and several other things that made it hard to make any allowance for expansion. As a matter of fact, he had allowed the wrong way and the probabilities were that his 1/32 in. would have been added to the expansion instead of subtracting from it, so he was making matters worse instead of better.

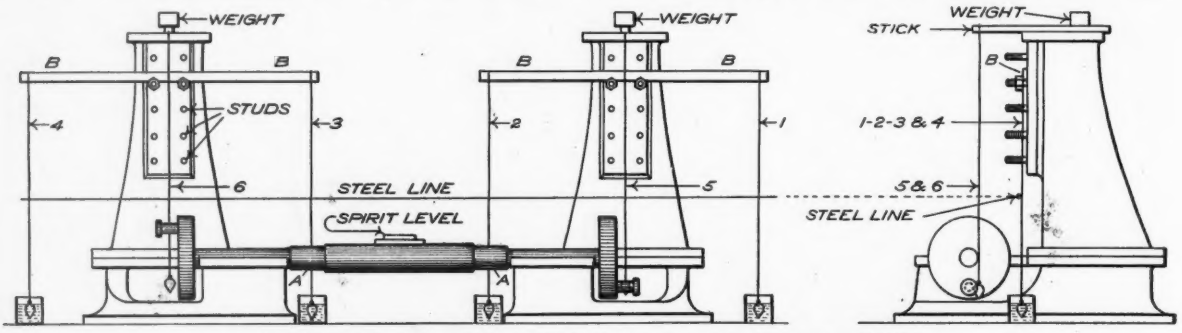
Another point is that there is always a certain amount of lost motion left between the shoulder on the shaft and the main bearings and also between the crankpin boxes and the cap of the pin. It is supposed to be enough to allow for the expansion of the shaft, and the expansion of the frames should be equal so that no allowances can be made for that. It is needless to say that when this engine was cemented she was in as perfect line as I could get her.

Let's Get Busy

We have wasted enough time in talk, let's get on the job. Our engine has flat slipper crossheads and flat guides, the guides being separate from the back columns and bolted to them. We get them in place, leaving the distance pieces and top sides off. We now need 2 long steel straight edges and they must be accurate. We shall also want six plumb bobs and a fine piano wire. A pair of inside calipers and a surface gage will complete the list of tools we need. No!—I nearly forgot the most important tool of all—a level with a very sensitive ground glass bubble.

Leveling

We have decided to have the shaft in place and have lowered it into the bearings and our first move will be to get it about level. If we have screws in the bases to level with, we shall notice whether the bottoms of the bases are at the level of the floor and, if they are about right, raise one base and lower the other until the shaft shows about level when the spirit level is put on the middle of the shaft. The



ARRANGEMENT OF PLUMB BOBS AND WIRE FOR SETTING ENGINE

straight edges should be about 6 ft. long and should be laid on 2 of the studs which hold the guides to the column and nuts put on the studs and turned down on the straight edges so that they will be held firmly with their edges up against the guides. They will be parallel to the guides and shaft. The straight edges project each side of the guides. The next step is to hang a plumb bob from each end of each straight enge, making 4 bobs in all. The cord should be as fine and smooth as possible, strong black silk will do nicely, and have the bobs heavy so as to hang steady. In order to keep them from swinging, old tin cans nearly full of cylinder oil set so that the bobs will hang free in the oil, will be found efficacious.

We may as well put up the other lines, although they will not be wanted just yet. The piano wire is to be set parallel with the shaft and so placed that it may be made to touch the 4 plumb lines which we have just put up. The remaining 2 plumb lines are dropped from sticks which we fasten to the tops of the columns and will hang at a convenient distance in front of the guides. The sketches will show the entire arrangement. AA is the shaft, BB the straight edges, 1, 2, 3, 4, 5, and 6 are the plumb bob lines.

Placing The Guides

Now if we measure from the lines 2 and 3 with a pair of inside calipers and move the bases in such a way that the distance to the shaft is the same in both cases, being sure the diameter of the shaft is exactly the same at the points from which we measure, and

then set the horizontal line so that it just touches lines 2 and 3 and then find that lines 1 and 4 also just exactly touch the steel line, it will be evident that lines 1, 2, 3, 4, and the shaft will be exactly parallel and consequently the guides are parallel to the shaft. We next take the surface gage and measure the distance from the guides at their tops to the lines 5 and 6 and then try the bottoms of the guides and if the guides are exactly perpendicular the distances top and bottom will be equal. Now our guides may be parallel to the shaft and perpendicular on their faces and not so on their edges. Using the surface gage from the edge of the guides and measuring from lines 5 and 6 we can easily discover whether there is an error in this direction. Of course it is understood that all these measurements must be kept going at the same time as any movement of the parts will quite likely make a change in several directions.

The final test will have to show the shaft level in the bearings, the guides exactly parallel to it and perpendicular in both directions and the proper amount of end play allowed between the disks and the bearings. We can prove up the shaft level by revolving it in the bearings and measuring from the ends of the crankpins to lines 5 and 6 when the pins are at the top and bottom positions.

If all of these measurements check up satisfactorily we are ready for the next operation which is the cementing of the bases to the foundation. Before this is done, get the chief engineer of the plant and the superintendent if possible to check up your lines and then have them sign a statement that they are found correct. This will often save trouble for your firm, more especially if there is any question as to the reliability of the foundation on which the engine is placed. It does not cost anything and may be of use in the future.

Cementing

Have a dam built about the bases high enough so that cement will rise above the bottom of the base at least 1 in. and then have a good brand of Portland cement used with about 2 to 3 parts of sharp, fine sand added. Have it intimately mixed dry and then add water enough so that it will pour freely and penetrate every nook and corner of the base and foundation bolt holes. When the cement is set hard enough so that it will not run out of the sides, take away the dam and trim off the cement around the bases neatly and also pour enough more into the base to fill it at least 3 in. above the bottom. We shall have to leave things for a day and turn our attention to other work while the cement is hardening as it will not do to touch the bases or shaft until the cement is solid.

Filling The Base

We remember that the bases and back columns are hollow and we know that if we strike them with a hammer they will ring like a bell. This may cause the engine to make a great deal of noise when running and it will be best to stop it, if possible. I have found the following plan to work excellently in every case: fill the base and back columns full of sand, well packed. To do this we take care to stop all bolt holes that go clear through the metal with waste, and see that it goes clear through. Have a man go down into the bases and pass the sand to him in a bucket and have him tamp it well as it is put in.

When we get the sand filled in to about 2 or 3 in. from the joint where the columns join the bases, put on a layer of cement about 5 or 6 in. deep so that the joint will be thoroughly covered and also have a few handfuls of cement mixed rather stiff placed over each of the holes as you come to them. This is to keep the loose sand from working out through the joints and holes. This plan has another advantage aside from keeping the engine free from noise;—it prevents a great deal of vibration.

The sand seems to deaden the whole frame and make it much more stable than it would otherwise be. The sand should be slightly dampened so as to pack well. When the back columns are filled to within 6 in. of the top, finish off with a layer of cement and let the whole thing set.

By the time that we have finished with the sand, the cement will have set enough under the bases so that the nuts on the foundation bolts can be set up and we can make a final check up of the lines which should be found all right; then we can take the shaft out, if necessary. Before we do so, we should put a thin coating of red lead on the bearings and turn the shaft in the bearings so that we can scrape the babbit where needed. We lift the shaft just enough to take out the shells and do whatever scraping is necessary and keep trying until the bearings show that the shaft is bearing well on the shells. Then take the shaft out and place it out of the way and get the lower half of the generator frame and one half of the wheel into the wheel pit. The generator should be handled by the electrical people unless there is an understanding that the engine builders are to do the work.

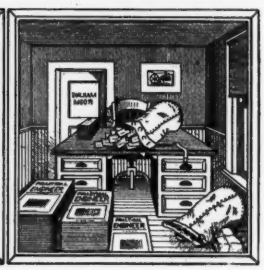
On an engine as large as the one we have in hand, the armature will have to be put on the shaft after it is received at the plant. In case of small engines it is usual to have the armature pressed on in the shop and all shipped together, and in that case the erecting engineer for the electrical company should handle the shaft and armature from the time it is received until it is in place in the main bearings. This is sometimes the cause of considerable controversy between the 2 erecting men and it is wise to have the point decided from headquarters before leaving the shop. The reason for the generator people having the handling of the shaft is that, as the armature is so much more liable to accident than the shaft, they should be the ones on whom the greatest responsibility falls. The engineman should keep an eye on the work and see that his shaft is not damaged while being handled, but should not attempt to take the responsibility from the shoulders of the electrical engineer. If he thinks the shaft in danger, he should call the electrical engineer's attention to it but cannot compel him to change his method of work.

Just a few words of comment in closing on the lining of an engine. Some of you will be surprised that the cylinder was not put in place and lines dropped through it. This is not necessary as the guides are the important thing and, if they are right, the cylinders will also be right, if the work has been done correctly in the shop. When we come to put the cylinders in place, we can try them with a line and, if they are not in perfect line, it may be possible to correct what error there is by adjustment of the lower heads as will be explained later on.

As it is, we have the engine bases and guides in perfect line and almost at the very beginning of the work. We can go ahead with other things without having a snarl of heavy parts in our way while we are lining. In a word, we have got something permanent to work to from at the very first. It is for this reason that I like to line up and cement the frames almost the first thing.

Letters From Engineers

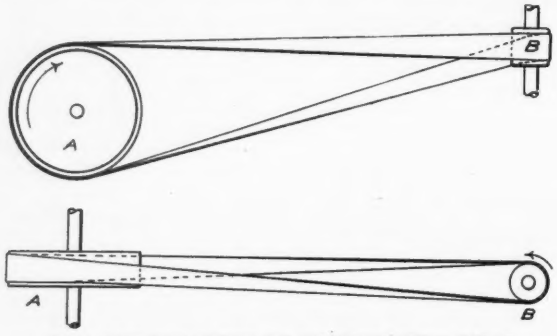
Tell us about your new kinks and new thinks. Rough sketches are always helpful; we make the drawings. Cash paid for accepted contributions.



Quarter Turn Belts

In regard to the quarter turn belt described by L. F. S. in the December number, if the pulleys are properly set, no idlers will be necessary and should never be used because such a quarter turn drive, even at its best, requires more power for doing a certain amount of work than a first class continuous belt, to say nothing of the extra expense and attention required for the 2 idlers.

In the side elevation the center of the face of the vertical pulley B is on a level with the top face of pulley A when running as indicated. In the plan view



SIDE AND TOP VIEWS OF QUARTER TURN BELTS

the center of pulley A is in line with the face of pulley B. In other words the belt leading from A to B must be straight or horizontal but will be at an angle equal to the diameter of pulley B and the belt leading from pulley B to A must also be in line but will be at an angle equal to the diameter of A, hence when viewed either way there will be one straight and one angle belt.

This will run alright providing the belt does not get too slack; in that case it may slip off pulley B when starting the machine, or it may slip down when not running. To avoid this, the writer has frequently fastened a guard under the edge of pulley B. This, however, is only required where the difference in diameters of pulleys is as great, and the distance between centers of shafts as short as those shown in this sketch.

The pulleys, however, should be some wider than the belt to allow good contact by reason of the angularity of the belt. The vertical pulley can be changed to run right hand by simply moving pulley A the diameter of pulley B. Old Machinist.

What I Found

I am surprised at the class of men we find in charge of engine rooms in this neck of the woods. I was taking in the sights one day this week, and happened to drop into an engine room, where there was up to date machinery, plenty to do with, and as I found out no one to do it.

I don't like to knock, but cannot keep still, as that starter and stopper was drawing $75 a month and could not pack a boiler feed pump to save his life. When we started a little conversation on this large subject of steam engineering I thought I would ask him a few questions, as I am always trying to learn, and appreciate being shown.

Here is one question I asked him: "You are a reader of Practical Engineer, are you not, Mr. Starter?" "No, I am not; they don't do a fellow any good, and my expense is too heavy now." (Me) "Have you an indicator?" (Starter) "Yes, can't you see it over there on the wall."

Well, I looked at the engine when I asked him, and saw that her cylinder was not piped, so I looked over on the wall and found a Bristol Recording Pressure Gauge for steam and I don't think the chart had ever been changed by the looks of the lines.

I did not ask any more questions for information, but thanked him for what I had learned and left by the door, as the roof was steel and I did not care to go that way.

Now boys, these are facts, and I have been in more places than one in the last 3 months and found such runners. I think "runners" is right as they would be the first to the atmosphere if anything started. We want State License laws and want them quick, as such men as these are killing our vocation. You know as well as I do that many good, well posted engineers, are working for less than $75 a month for the simple reason that employers pay the money to the man who can hand out the best bunch of conversation. A man's past record don't seem to spell anything now-a-days. I would like to hear from some one else on this subject as I am a better reader than writer. R. Cadwell.

Compound Engine Receiver Pressure

We have a problem that is rather difficult to solve and would like your assistance in the matter. In this plant we have a 14 by 28 by 36 in. Allis Chalmers cross-compound, condensing engine, the steam supply for which is furnished by 2 horizontal return tubular boilers, each 66 in. diameter by 18 ft. long, and our pressure is limited to 125 lb.

Steam is conveyed from boilers to engine through a 5-in. steam line, passing 3 elbows and entering a 5-in. vertical Austin separator just above the throttle. After leaving this cylinder it exhausts into the usual receiver between the 2 engine cylinders and thence into the low-pressure cylinder.

Now it is generally conceded that if you want to put more work on the low-pressure cylinder you must raise the receiver pressure to do it. But, in this case, if we raise the receiver pressure above 10 lb. it only backs up on the high-pressure cylinder and causes it to carry the steam valves, taking steam full stroke; or, in other words, raising the receiver pressure to get

more work out of the low-pressure cylinder only puts more work on the high-pressure cylinder, caused by choking her exhaust, and causing her to take steam full stroke.

As our feed-water heater is a closed live steam heater and we could not turn the exhaust from the pumps into it we had to devise some means to make away with the exhaust from these pumps; so we tapped the end of the receiver and piped the exhaust

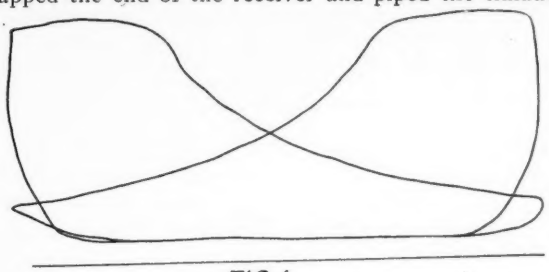


FIG. 1

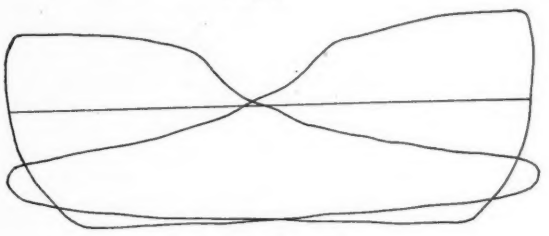


FIG. 2

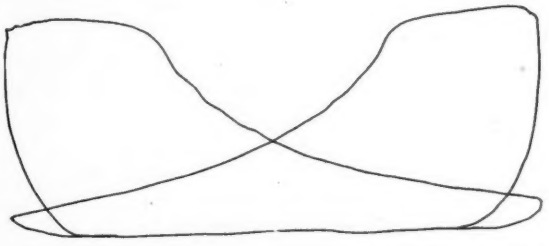


FIG. 3

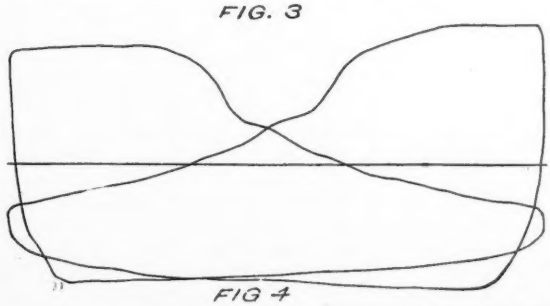


FIG 4

FIG. 1. HIGH-PRESSURE CARD WITH PUMP EXHAUST TURNED OUT OF RECEIVER

FIG. 2. LOW-PRESSURE CARD, PUMP EXHAUST TURNED OUTSIDE

FIG. 3. HIGH-PRESSURE CARD WITH PUMP EXHAUST USED IN RECEIVER.

FIG. 4. LOW-PRESSURE CARD, PUMP EXHAUST USED

from the 5¼ by 3½ by 5 Dean boiler feed pump and also the exhaust from an 8 by 10 by 12 Burnham circulating pump into the receiver, which would raise the pressure to 13 and 14 lb. This released the load on the high-pressure cylinder, made a much earlier cutoff and at the same time caused the low-pressure cylinder to do 20 hp. more work, as plainly shown by the enclosed indicator diagrams.

Now, why is it that we can not build this receiver pressure up to 14 lb. with her own steam and get the same results? or, why is it that this exhaust steam that is turned into the receiver until it builds up to 14 lb. does not choke the high-pressure cylinder the same as it does to build up that same pressure with her own steam? E. A. B.

Result of Bent Valve Rod

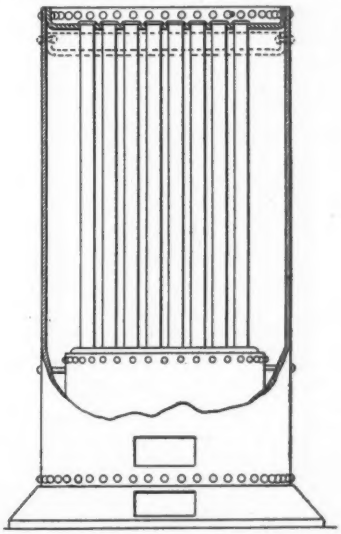
I will here tell of an incident that came under my observation some time ago on a fishing steamer, in which the steamer was delayed 24 hr. with a large crew in the height of the fishing season, which meant a considerable loss to the owners and crew as well.

The engineer discovered there was something out of order with the valve arrangement and thought it was taking considerable more steam pressure than usual, in fact, she would not run at half of her usual speed.

In taking off the steam chest cover and examining the valve we found the valve stem was bent so much it would not cover the lower steam port and the upper edge of the valve had cut the valve seat badly. The cause was plainly to be seen, excessive compression and the lifting of the valve.—Wm. C. D.

Boiler Leakage

About a year ago one of our cranes was driven by steam power, a small vertical fire-tube boiler being



DROPPING A VERTICAL BOILER HEAD TO AVOID RETUBING

used. One day it was noticed that the top head leaked badly around the tubes, and upon examination it was found that the head was corroded badly at the tubes and many other points, due to the water coming through the smokestack when it rained.

It was decided to repair the boiler at once but when removing the head and tubes, it was found that both ends of the tubes were in bad condition, so that new tubes were necessary. As the boiler would only be used perhaps 6 mo. longer when the crane would be changed and driven by motors, so that it would not pay to put in new tubes or repair the old tubes by welding a piece on to make them long enough, it was decided to cut off the bad part on each end of the tube, and drop the head as shown in the illustration, as a new head was necessary. H. Jahnke.

Scale in the Blowoff

Reading the article on Engineering in the Country brings to mind an occurrence I witnessed at a certain plant a year or two ago.

It is the custom at this plant to blow down the boilers at 6:30 a. m., at 12:30 and at 7 p. m. On the day in question the boilers had been blown down as usual before starting up in the morning and both blow-off valves worked first rate. The battery consists of 2 horizontal return tubular boilers carrying 80 lb. gage pressure.

At 12:30 the fireman having let the pressure go down, went around and opened the blowoff valve on boiler No. 1; after allowing it to blow off for a few seconds, he tried to close it but found that it had stuck fast. About this time the low water whistle started to blow which didn't tend to steady the fireman's nerves any. He made at once a record breaking dash to get the engineer who had a try at closing the valve but the attempt was unsuccessful. They then got busy drawing the fire and they didn't need anybody to tell them to hurry about doing it either. Some of the mill hands who had gathered at the scene of action got pails of water to put out the fire, which had been drawn out on the boiler room floor, to keep it from spreading to a pile of dry waste material which was dumped near the boilers by conveyor and used as fuel. This necessitated pretty rapid action on their part as the floor was covered with dry shavings, sawdust, etc.

In the meantime some zealous person got down the fire hose and started wetting down everything in the room, including anybody standing within reach, and after they got done slashing water about that floor looked as if it had been visited by a cloud burst or suddenly transformed into a miniature lake.

Well, after the boiler had cooled down sufficiently the engineer started to disconnect the blowoff but first gave the valve stem a turn and to his surprise found that it would shut tight. The piece of scale which had held it open had afterward become dislodged and blown out saving him a tedious job and much forceful language. LeRoy Scott.

Diagram for Analysis

I am enclosing an indicator diagram taken from a 12 by 18-in. Russell engine running 220 r. p. m., boiler pressure 70 lb. and taken with a 54-lb. spring.

I would be glad to hear from readers of Practical Engineer what they think of it and how it can be improved. This is a riding valve gear with shaft governor. J. A. Layman.

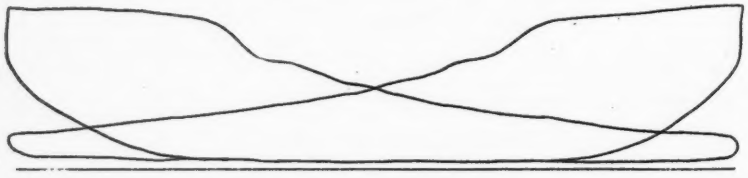


DIAGRAM FROM RUSSELL ENGINE FOR ANALYSIS

Engine Bed Designs

To answer the questions asked by H. L. W. in Practical Engineer on page 682, November, 1909, is a somewhat difficult matter, as he does not state what type of cylinder he has, whether it is intended to fasten by the front head or by side lugs and this one point has a great bearing on the main engine frame, on which he asked for suggestions, while the cross-head has little or no bearing on the design of the main frame.

As being either horizontal or a vertical type, we are presenting 2 types of frames, simple but modern and quite easily made. Figure 1 shows a box form of bed which is intended for a cylinder having side lugs for fastening it to the frame. This same type of frame can be used with a cylinder having front end fastening by simply putting a flange on the end of the bed. A section through the bed is shown at C D. The Z

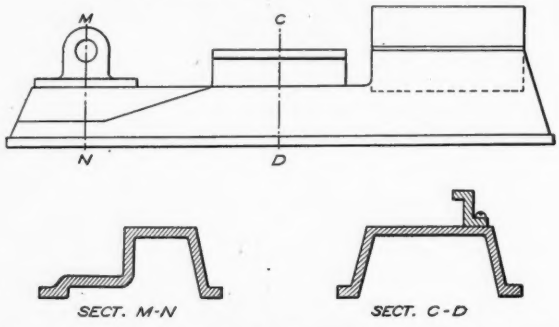


FIG. 1—FRAME DESIGN FOR HORIZONTAL SIDE LUG CYLINDER ENGINE

shaped guide is fastened to the bed by small screws and 1 pattern will answer for the 2 guides. This form is suggested to suit parts described by the engineer. M N shows the section through the frame at the main bearing. This makes a good substantial box frame and easily made by a novice.

We are also showing a vertical type of frame in Fig. 2, to be used with the same type of crosshead by

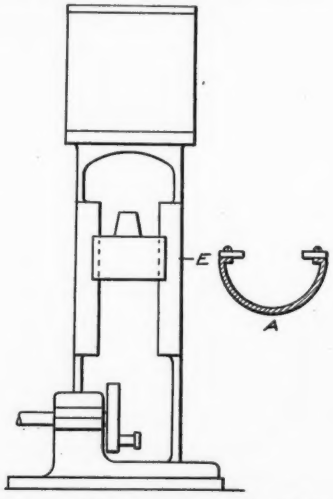


FIG. 2—FRAME FOR VERTICAL FLANGE END CYLINDER ENGINE

simply using 2 flat guide bars as shown. This frame can be made very pleasing in appearance by some care in the making of the pattern. A shows a section through the main frame at E showing method of securing the guide bars. This frame is shown for securing the cylinder to the main frame by the front head. As this is a usual practice in the building of upright engines, we hope the suggestions will answer the purpose. C. R. McGahey.

Hookworm or Bad Judgment

I know of a plant close by that was recently built where the engineer generally reads some 10-cent story magazine. He did the job of pipe fitting and put 2 3-in. pipes the whole length of the building, 200 ft., and left them uncovered, where he could have put in a 4.5-in. and had a little margin in area, and would have saved about 190 lb. of coal a day leaving them uncovered same as the other 2, saying nothing about the cost of covering the 2 3-in. pipes. I think it would cost less to cover 4.5-in. pipe. Is this statement not correct?

In putting in the combustion chamber, he did not put in any headers; I would like to know how repairs can be made to the fire brick?

They pay $10 a week for an engineer, the building alone cost about $75,000, 211 by 60 ft. That company never thinks of covering its steam lines or hot water pipe, and feeds the boilers through the blowoff.

Grover Wetherho.

What Caused the Bag in This Boiler? An Engine Knock. Boiler Tube Ferrules. Fluid Pressure

At the plant where I am working, a boiler was recently burned, and the burned spot formed a bag about 8 in. diameter, and stretched until the material opened up and let a stream of water upon the fire. A piece 42 in. square was cut out and a patch put on.

When the bag was examined, a mass of soft muddy scale was found that had the appearance of magnesia. The master mechanic said that it was an oil burn; the assistant said that it was a scale burn; now which was it?

It had been the rule to blow this boiler down twice a day but the regular licensed fireman was away sick and an inexperienced man was in his place; though he says that he blew down, the probability is that he did not. The bag shows no traces of oil that I can discover, but the facts are as follows:

Feed water is heated in an open heater that receives exhaust steam from 2 pumps and 3 small engines, their total horsepower being not over 50. Exhaust goes straight to the heater without passing through a grease extractor and of course a portion of the oil must enter the boiler. The boiler has been fired up and cooled down and the patch examined; it is about 18 in. from the front tube sheet; when it was cooled down, the patch was found to leak a little all around, and the master mechanic, when told of it said that that meant nothing as it was always bound to leak when cold, but would take up when hot. I would like to hear from readers of Practical Engineer what they think of this case.

In regard to the knock mentioned in the pillow block of his engine by A. J. W., I had an experience while operating a plant about 2 yr. ago which may be of interest. One unit was an 80-hp. Corliss horizontal engine driving an ice machine direct; as long as the steam pressure was under 95 lb., this engine ran nice and quiet, but when it was above that, there developed a knock in the crank as it passed over the outer center, and a click in the flywheel. This engine was in line and level with the flywheel carefully balanced, but it had a twist in it that threw it out about 3/8 in. on one side. The flywheel was 10 ft. diameter.

I would like to know if it is the custom for the rear ends of tubes in return tubular boilers to be made with copper ferrules. I am informed that they are always made that way, though I had never known it before. The boilers here are made so, and the tubes don't seem to be able to make a run of 4 weeks without a number of them leaking so that they have to be rolled; this has been going on until very soon it will be necessary to renew the tubes.

On p. 609, October, 1909, is an explanation of the pressure on a bumped head in which the pressure is shown as acting at all points in a direction parallel to the sides of the boiler. All my teaching has been that water, steam and gases exert pressure in all directions equally, and it is this that causes all vessels containing them to tend to become cylindrical in form. In fact it is Pascal's law that "The pressure per unit of area exerted anywhere on a liquid is transmitted undiminished in all directions and acts with the same force on all surfaces at right angles to the surfaces." And this law applies to steam.

Hays Skaton.

An Oil Pumping Device

Herewith is a sketch of an arrangement that we have used for pumping oil on an automatic engine or a Westinghouse air pump. In the exhaust from the engine a tee is placed and on the end is attached a grease cup rigged with a piston on top of which is a weak spring as shown in the sectional view. From the piston a rod runs through the cover of the cup in a packing nut, and a small air hole allows the compression above the piston to escape.

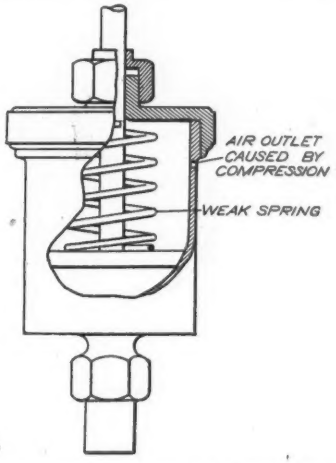


FIG. 1—SECTIONAL VIEW OF COMPRESSION CUP

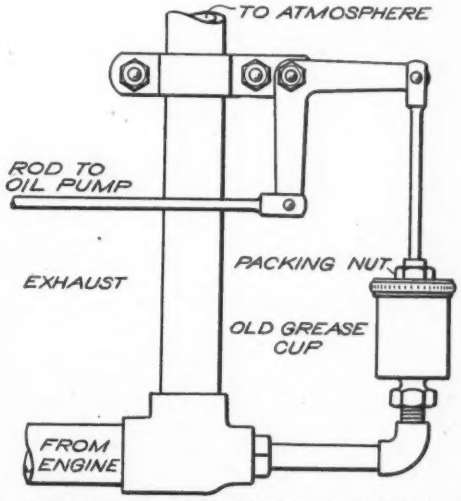
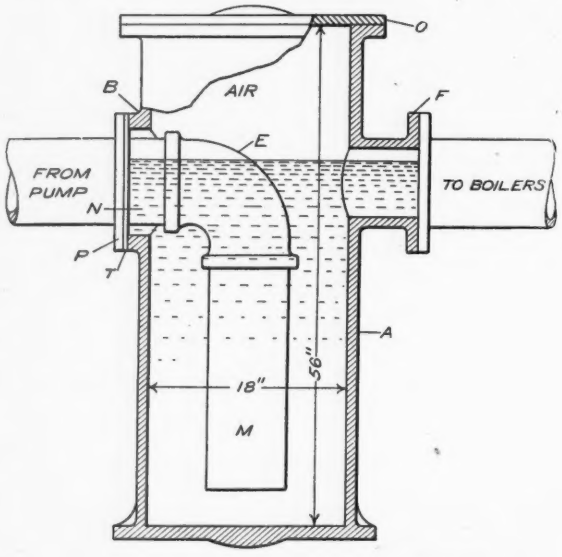


FIG. 2—ARRANGEMENT OF DEVICE FOR DRIVING OIL PUMP

The piston rod drives a bell crank lever, and from the other end is taken a rod running to the oil pump. In this way the pump gets an impulse at each stroke of the engine or pump. Earl Watkins .

Home Made Air Chamber

We had one large feed water pump serving 5 small boilers and with all the elbows, valves and other connections that mysterious bug bear of steam plants, "water hammer" was quite dangerous.



AN EFFECTIVE HOME-MADE AIR CHAMBER

The figure shows a home made air chamber which solved the question very satisfactorily. Of course the air cushion is the principle but the construction of this chamber is simple and proved effective. The main body A is a cast iron shell with flange F and boss B, all cast solid and likewise the bottom is cast with the body. The elbow E with the 2 nipples M and N is made separate. After being put together the nipple N is passed through the opening in the boss and then the 2 flanges P and T are bolted to the boss, and then the top O is put in position. All fittings are for high pressure. R. A. Anderson.

Connecting Rod Bolts

On page 735 December issue of Practical Engineer there appeared an article entitled Connecting Rod Bolts by J. K. B. On reading over the article I find that he recommends hollow bolts for the connecting rod where solid bolts failed. For the benefit of the many readers of the paper I wish he would go farther and tell why hollow bolts are stronger than solid bolts. I agree with him that bolts are sometimes injured in the making by carelessness in the heating and also in the machining, but I cannot understand how a 1-in. bolt hollow can be as strong as a 1-in. bolt solid, for in the first place the area of the metal is only 0.7854-0.0491 sq. in., while in the solid its area is 0.7854 and as the tensile strength of iron or steel is measured by the square inch it goes to show that a hollow bolt will not have the same number of square inches as the solid bolt of the same outside diameter.

I have seen hollow shafts for large engines but it was not intended to strengthen but to lighten the load on the bearing; I have never heard of a designing engineer recommending hollow bolts where solid ones failed. Readers of Practical Engineer, what do you think? M. J. C.

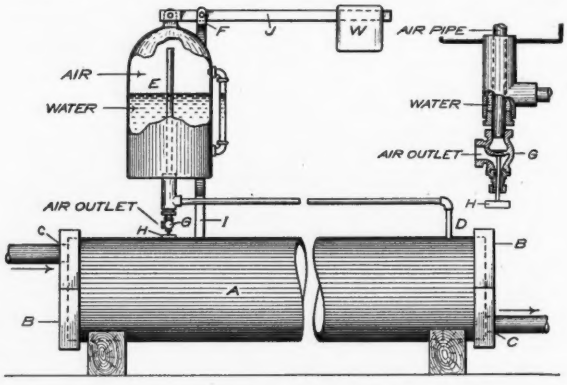
Separating Air From Water

We have had some trouble with air in our water which was very annoying to say the least, and the way we got rid of it may be of interest to other engineers.

We pump our water from two wells 210 ft. deep. The water entering the system direct from the pumps, any surplus backing up into a tank located outside the buildings. No doubt it would take the air out to pump into the tank through a separate line but this would necessitate laying another line which would be rather expensive.

After considering several plans we adopted the following homespun one:

A piece of 12-in. pipe A, 8 ft. long was capped at both ends as at B and B; a 2-in. opening at C was connected with the pumps, and a 2-in. opening at C was connected with the system. From D a ½-in. line was run back along pipe A 7 ft. and connected to a tank E and valve G, the threads on the stem of valve



METHOD OF REMOVING AIR FROM WATER

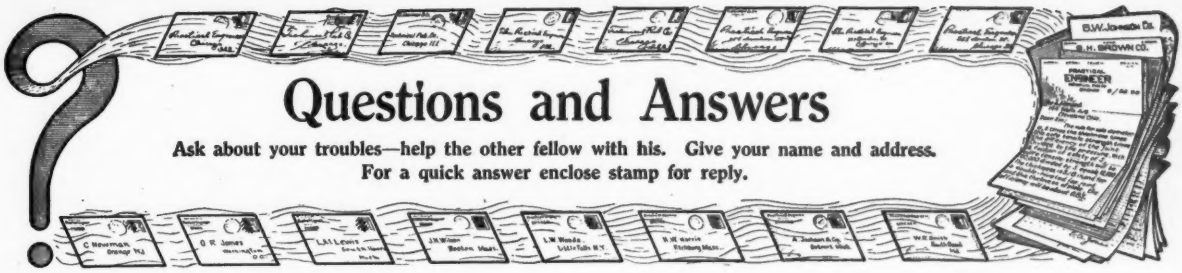
G were filed off, the stem resting on block H, the connection to tank E extended through a bushing to near the top of the tank. A lever J and weight W with fulcrum at F were attached to balance tank E. I is a rod resting on tank A and acting as a fulcrum for lever J at F.

The water entering at the top and leaving at the bottom of tank A caused the air to collect at D and follow the ½-in. line to tank E. When tank E was full of water its weight kept valve G closed. As air collected the water went back to tank A, and tank E became light enough for lever J to raise it which opened valve G allowing the air to escape.

The arrangement has been working satisfactory and we are not bothered with air in the system.
H. C. F.

Drainage of Heating Coils

In the plant where I work there are 21 office radiators and coils located at different rooms in the factory, some near the ceiling and some near the floor, containing 2,664 sq. ft. of radiation. The coils farthest from the pump are about 275 ft. away and are operated on the Webster return vacuum system. All return pipes pitch towards the pump into a 6-in. header, the pump being 4 x 5 x 8 inches, a Marsh pump, and yet we do not get the proper drainage and cannot create a vacuum at the pump. Can some of the readers help us out? A. Hewitt.



Questions and Answers

Ask about your troubles—help the other fellow with his. Give your name and address. For a quick answer enclose stamp for reply.

Steam Properties; Boiler Horsepower

1. What is the total temperature of steam?

2. Is there a short rule to find the temperature at the different pressures?

3. What effect will it have on a boiler at 125 lb. to be suddenly turned in a line at 100 lb. pressure; what effect does the temperature have?

4. What capacity boiler is required for the following engines running condensing and non-condensing: Slide valve engine at 100 hp., Corliss engine at 100 hp., automatic cutoff at 125 hp., compound Corliss at 200 hp.? G. S.

A. The total temperature of steam is the temperature above absolute zero, and is equal to the Fahrenheit temperature plus 460.7 deg.

2. The best way to find the temperature at different pressures is from one of the numerous steam tables published. The method of computing the temperature for any given pressure is quite laborious and there is no simple rule for doing it. It involves logarithms and higher mathematics.

3. If a boiler at 125 lb. is suddenly turned on a line at 100 lb., the steam will, of course, rush from the boiler into the line rapidly and a large amount of steam will be generated very rapidly in the boiler, because the temperature of the entire mass of steam and water in the boiler, which is at 353 deg. F., will tend to drop to 338 deg., the temperature corresponding to 100 lb. pressure. This is likely to produce foaming in the boiler, and if the opening from the boiler to the line is a big one it may even produce a churning of almost the entire mass of water into foam, which will tend to create great strains in the joints and may result in overheating of the furnace plates.

4. A 100-hp. slide valve engine running noncondensing would use about 5,000 lb. of steam an hour and take a boiler of about 167 hp. If this engine ran condensing it probably would take about 4,500 lb. of steam an hour and would require a 150-hp. boiler. For an automatic cutoff engine of 125 hp. the steam used would be about 5,000 lb., requiring 167 boiler horsepower. If run condensing this would take about 4,400 lb. of water an hour and require a boiler of 146 hp. A Corliss engine, noncondensing, 100 hp., would take about 3,000 lb. and require about a 100-hp. boiler; run condensing it would take about 2,500 lb. and require a boiler of 85 hp. A Corliss compound at 200 hp. would be run condensing and would take about 4,000 lb. of water, require a boiler of about 135 hp. These figures are approximate and, of course, would vary with the steam pressure at which the steam was furnished.

Safe Diameter for Boiler

We have a boiler 3/8 in. thick, double-riveted lap joint, carrying 100 lb. steam pressure, the plate having a tensile strength of 60,000 lb. per square inch. What is the safe diameter for this boiler? J. H. K.

A.—The rule for safe diameter is: 2 times the thickness times the safe tensile strength times the efficiency of the joint divided by the pressure. With a factor of 5, the safe tensile strength will be 60,000 divided by 5 equals 12,000. The thickness is 3/8 in. and for a double-riveted lap joint and this thickness of plate, the efficiency will be about 0.83. The diameter will then be $2 \times 3/8 \times 12{,}000 \times 0.83 \div 100$, which equals 74.5 in.

Late Eccentric

How can I get a good card off this engine, which is a Slater? The high-pressure is good but the low is not. Just what is the matter? C. E.

A.—All the events of the cycle seem to be late. The head and crank end cards are quite uniform, but

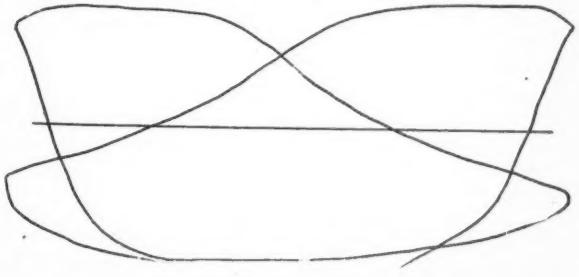


DIAGRAM FROM SLATER ENGINE; ECCENTRIC SLIPPED BACKWARD. 32 IN. DIAM.; 42 IN. STROKE; 80 R.P.M.; BOILER PRESSURE 110 LB.; VACUUM, 25.5 IN.; SCALE OF SPRING 12; RECEIVER, 10 LB.

admission, cutoff, and release all come too late and the eccentric should be advanced to bring these events at the proper time.

Steam Pump Dimensions

Kindly calculate the pump dimensions and rating necessary to perform the work indicated by the following data: Diameter of water cylinder 6 in., stroke 10 in., speed 60 strokes per minute pumping water against a head of 440 ft. J. K.

A.—It is assumed that 100 lb. steam pressure is available. For a pump 6 by 10 in., 60 strokes a minuate, a 6-in. cylinder would have an area 28.27 sq. in. and the cylinder would, therefore, draw 282.7 cu. in. per stroke or, at 231 cu. in. per gal., it would draw 1.225 gal. per stroke, and at 60 strokes a minute this would be 73.5 gal. per minute.

Each gallon weighs 8.33 lb., so that the power required in lifting the water would be 612, the number of pounds lifted, times 440 ft., the height, divided by 33,000, or 8.18 hp. Allowing for the slip and friction of the pump, which would probably be 30 per cent, this would give about 11.7 hp. to be furnished by the steam cylinder, and a steam pump of this size would

require in the region of 120 lb. of steam per horsepower hour, or 1,405 lb. of steam total per hour.

The pressure for 440 ft. head would be 190.5 lb. Assuming that steam pressure is 100 lb., then the area of the steam piston will be to that of the water piston inversely as the pressure that is to be carried, or as 100 is to 190.5, so is 28.7 to the area required. This gives an area of 53.9 sq. in., which would call for a steam piston 8.25 in. diameter.

Central Station vs. Steam Plant Lighting

Q. I am running a cold storage plant with 1,000,000 cu. ft. capacity and an 80-ton ice plant. Coal costs us $1.65 in front of the boilers. For furnishing current to the lighting system we have a pair of Westinghouse compound engines 9 and 15 by 9 in., direct connected to 27.5 kw. generators at 110 volts. One of these is run at a time, with an average day load of about 85 amperes for 12 hr. and an average night load of 60 amperes for 12 hr. We have also 3 steam-driven elevators of the Otis type, 2 engines on each elevator, 7 by 10 in., the elevators running at an average speed of 100 ft. a minute and the heaviest load being 3,500 lb. These are in a 7-story building and we figure that they run steadily for 10 hr. a day except the time for loading and unloading. Central station current is offered us at 3.5 cents a kilowatt hour for running the lighting plant and the elevators, putting in electric motors to drive the elevators. If our engines were put in good condition would it be better policy for us to keep on driving the lighting units and the elevators by steam or to shut these engines down and buy electric current? What would you estimate as the saving?

W. C.

A. Although you do not say so directly, you probably have to run a steam plant anyway for the cold storage and ice-making machinery. Under those conditions, the extra labor of running the elevator plant and the electric generating units will be but a small expense.

Presumably you are using about all your exhaust steam as condensed water for the ice plant anyway, so that it is hardly possible that you would make any saving by buying your current from outside. The few figures herewith are only approximate but will perhaps help you to do a little figuring on your own account.

For the 12 hr. that you use 85 amp. you will be taking 9.35 kw., and use 112.2 kw.hr., which at 3.5 cents would amount to $3.93. For the 12 hr. that you are using 60 amp. you are drawing 6.6 kw. and use 79.2 kw.-hr., which would cost $2.77. Your cost for current would then be $6.70 per day of 24 hr.

The horsepower used by the elevators is largely a matter of guess work but a load of 3,500 lb. at 100 ft. a minute would mean 350,000 ft.-lb. a minute, or about 10.6 hp. Running 10 hr. this would call for 106 hp.-hr. but that would mean continual run, and it is probable that the car is running not over half the time. On this basis 53 hp.-hr. would be called for, and that at 3.5 cents a kilowatt hour would be $1.38 or a total of $8.08 a day for current.

As to the cost of running this plant by steam, your total electric consumption is 191.4 kw.-hr. per day. Allowing 5 lb. of coal per kilowatt-hour you would use 957 lb. of coal, and allowing 5 lb. of coal per horsepower-hour on the elevators would call for 265 lb. of coal or a total of 1,222 lb. a day, which at $1.65 a ton would make a coal cost of $1.01.

Estimating the labor cost at $1 a day and the cost of supplies for these plants at 50 cents a day, the cost of repairs 20 cents a day, taking the year through, would mean a total cost of $2.71. Of course, this does not include cost of firing or boiler room attendance, as it is assumed that this will be no greater with this amount of apparatus than it would without it in a plant of your size.

You can see from these figures that it would probably be a losing proposition for you to buy your current outside. It may be probable that it would pay you to equip your plant with a different arrangement, putting in an electric drive for the elevators.

At the present time you are running the generator units at about ⅓ their capacity, which will not give good efficiency. If you throw the elevator load on the generators you are, of course, liable to have some variation in voltage on the lighting circuits as the elevator starts and stops, but in the lighting of such a plant as yours this would not be a vital defect and your generator engines will be much more economical of steam than the elevator engines.

ANSWERS TO MASSACHUSETTS THIRD CLASS EXAMINATION QUESTIONS

See December and January Issues

BY T. C. ROBINSON AND P. E. MERRIAM

TO THE December questions:

1. Determining whether the piston is at the head or crank end of the cylinder can be done by trying the cylinder cocks, although this will not be conclusive, if there is any leak around the piston or past the steam valve. Looking at the valve stem or rod will be a good check, as the wear on the valve stem where it slides through the packing will show

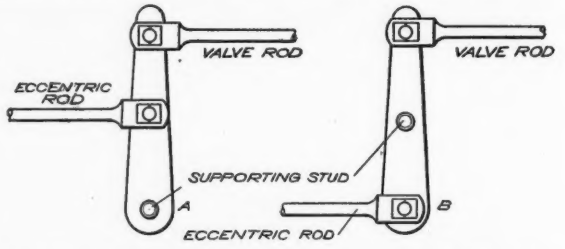


FIG. 1—DIRECT AND INDIRECT CONNECTION OF VALVE AND ECCENTRIC RODS THROUGH ROCKER ARM

in which direction the valve is standing.

With a direct driven valve, or one in which the eccentric rod and valve rod are connected on the same side of the supporting stud for the rocker, the eccentric would also be found at 90 deg. plus the angle advance ahead of the crank. If the valve rod and eccentric rod are connected to a rocker arm on opposite sides of the stud, the eccentric will be 90 deg. minus the angle of advance back of the crank. It is usually easy to determine from this which end of the cylinder is taking steam.

2. A good procedure to follow in taking up connecting rods is: Put the crank in such a position as will bring the part of greatest wear on the crank pin at right angle to the line of greatest force, as delivered to it by the steam and piston in the cylinder. This will bring the greatest diameter of the pin almost parallel with the center line of brasses, and as the key is driven down or the wedges drawn up, thus taking out the lost motion, the brasses will be keyed up on the thickest portion of the pin.

The liability of getting them drawn too close to the pin is thus lessened.

The connecting rod being on the crank or on the head end does not make any difference; the method of taking up or of lengthening the connecting rod remains the same for both ends. If it is too long to be sufficiently taken up by the keys or wedges, shims should be put in behind the brass end next to the wedge, i. e., the shim or shims should be placed between brass and wedge. Of course, shims may be used between the brass and heel of connecting rod on the outer end of the rod. These will serve until new brasses can be secured.

When boxes on the connecting rod are adjusted by key, strap and gib, as shown in Fig. 2A, draw a pencil line across both key and gib, using a straight edge for a guide; then loosen the set screw and drive the key

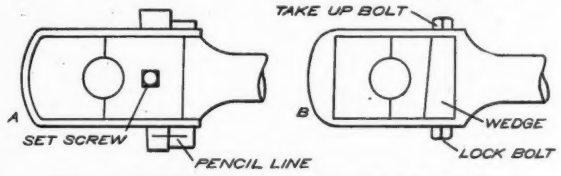


FIG. 2—METHODS OF KEYING UP ROD ENDS

with a soft faced hammer an amount equal to the thickness of the line, is a method frequently used. The set screw is tightened after the driving.

If a wedge with bolts at top and bottom is used to draw up and down, as in B, Fig. 2, and thus move the boxes, the lower nut is slackened and the upper one tightened until the right amount of play has been taken up, when the lower nut is again made tight.

3. If I found the connecting rod too short, I would examine the crankpin brasses and also the wristpin brasses, and, if possible, would have some metal filed or planed off the crank end brass of the crank pin brasses, also would, if necessary, do likewise with the head end brass of the wrist pin. I would also have some shims for the other 2 brasses, so as to enable me to key them up where they belonged.

4. There is no way of determining clearance that is so certain as the methods excluded. The clearance is often marked on the guides. Usually, if the crank end wristpin brasses are in good condition, not too badly worn and have been in use on this engine for some time, the clearance will be right.

The question was no doubt asked to see if the applicant knew that in a properly designed engine the boxes should be able to wear brass bound, that is, with the ends striking each other and yet not let the piston strike the cylinder head. If a careful engineer has been in charge of the plant the striking points for the crosshead will be marked, therefore in a well designed engine it should be possible, unless the crosshead box is brass bound, to run until it is convenient to measure the clearance carefully without having to make any guesses.

5. If the crosshead key cannot take up more wear make some shims and put them in between brasses and heel of connecting rod, i. e., next to key or wedge.

6. Boring the cylinder is done that it may have a smooth surface, prevent leaks, and also to make it cylindrical, and to bring the center of it in line with center of main journal.

7. The main pipe is tested for water on a Monday morning by opening a valve, which is located on a little pipe which in turn is attached to steam main, and which engineers refer to as the bleeder.

8. By noting the relative positions of the bell crank levers on a duplex pump they indicate by their position which valve is open. There is no such thing as both of the pistons of a duplex pump being at the end of their strokes at one and the same time, because that is not the principle of a duplex pump. One or the other of the pistons is always traveling; when one valve is shut, the other is open.

Start would also be indicated by the marks and also by the wear on the valve stems or valve rods. The valve which is the farthest removed from its center of travel as indicated by the evidences referred to will indicate the piston that would be the first to start when steam was turned on!

9. An outside packed plunger pump is one whose plungers move to and fro through a stuffing box on practically the same principle as that of a piston rod

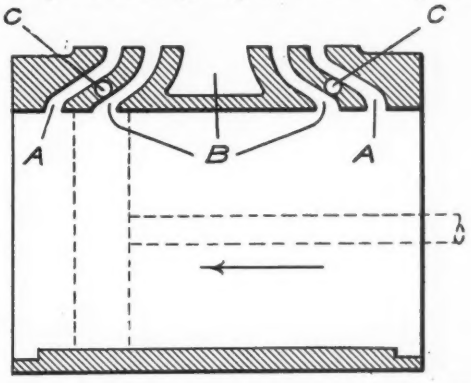


FIG. 3—SECTION OF DUPLEX PUMP VALVE SEAT

of a steam engine, the packing is pressed in the box and thus caused to adhere closely to the plunger by means of a gland, threaded studs and nuts provided for that purpose.

January

1. Where the water has disappeared from the gage glass in a boiler that has stood all night and under which the fire has gone out, it may be due to several causes. If the boiler has been forced before shutting down, there may have been sufficient heat in the walls to keep the water level up by foaming after the boiler stopped. Otherwise it looks like a catch question.

2. In a simple pump, direct acting, the reversal of the steam piston is caused by an auxiliary valve which moves the main steam valve to open the admission port ahead of the time that the piston reaches the end of the stroke. This furnishes sufficient pressure to absorb the momentum of the piston and reverse its motion.

In the duplex type, there are 5 ports on the valve seat and the outside ports A at each end, as shown in Fig. 3, are steam ports. As the piston passes the edge of these ports, a certain amount of steam is caught between the piston and the cylinder head and is compressed, acting as a cushion to stop the piston. In some cases, cushion valves C are fitted to large pumps to allow the stroke to be regulated within certain limits by increasing or decreasing the cushion formed by the steam.

3. Some pumps are arranged as shown in Fig. 3, having exhaust ports at each end and one in the center and also steam ports at each end which act as compression chambers. Other pumps are arranged with an exhaust port at each end and a steam port at each end, the valve allowing the steam from the steam port to exhaust through a cavity in the valve body into the exhaust port, thus doing away with the central port.

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FLOW OF WATER IN PIPES

Frequently it is desired to know the amount of water that can flow through a pipe in a minute under a given pressure or the size of pipe needed to carry a given amount of water per minute. It looks, on its face, like a simple problem and one for which an easy rule ought to be found.

When one begins to look for the rule, however, the situation gets serious. Of course, the amount that will flow depends on the velocity of flow, and that in turn on the fall in head or the difference between pressures at the ends of the pipe; but in what way? Things begin to get complicated by the "square root of the hydraulic mean radius" and other uncanny sounding elements.

It is a welcome relief to get a rule such as given by Mr. Mason in this issue which will give the desired flow with reasonable accuracy. The 5th power of the diameter may not seem simple, but it is obtainable and you know what it is when you get it. While the rule or equation given is, as stated by Mr. Mason, not absolutely correct, it is near enough to answer ordinary requirements, if the co-efficient of friction be carefully estimated. It is worth careful preservation for reference

THAT COAL BILL

Comes always the question, "Will my coal last through?" And with the bill comes always the gasp, "Will coal ever stop rising in price?" And scientific investigation of the available coal sources answers, "Probably not."

Well! And what then? We must learn in domestic economy as well as in the engine room to use the lower priced fuels to good advantage.

In this connection a bulletin issued by the Illinois Engineering Experiment Station is of great interest, for they show mostly that all present styles of house heating apparatus are reasonably well adapted to use anthracite coal but ill adapted to bituminous. Efficiencies run from 40 to 66 per cent, depending on the fuel and the conditions of forcing.

Coals high in volatile matter are not well fitted for the ordinary house boiler or furnace, and are almost sure to make smoke and burn at low efficiency; but even at that, the cost per 1,000 B.t.u. is less and the heat utilized per dollar's worth of fuel greater than with either Pocahontas coal from W. Va., or anthracite. This makes the use of western coals for household uses imperative, and it behooves those interested to see to it that makers of heating apparatus provide a firebox which can burn cheap western coal with good results.

EDITORIAL CHAT

Leading an Engine to Drink

Ordinarily when you want to get something out of the other fellow, you take him out for a good time and he may become more or less under the weather. It

is not considered nice in polite society to call it doping him, but it amounts to the same thing. Of course, it has to be carried to a point beyond the state of exhilaration, otherwise the stimulant may act as a quickener to his alertness.

In horse racing, however, it is different. Frequently an old has-been, that at one time had good speed, is taken out and made partly drunk to give him ginger which sometimes results in winning a race.

The latest proposition is to get your gasoline engine partly drunk with the same object in view. No wonder the combination engine has the name of being erratic. It can be seduced into such questionable habits but the American Machinist states that unscrupulous owners of racing boats are in the habit of sometimes doping the engine with Picric acid or other high explosives mixed with gasoline in order to ginger up the engine and give it extra power.

Of course, the question arises whether this is perfectly legitimate because the racing rules do not state what fuel shall be used in the engine.

We are not authorities on horse racing, but we opine that the method of doping a worn out race horse for the sake of winning a race is also legitimate just as much as making a finesse at bridge or drawing to a bob-tail flush. The result, however, in trying to get the gasoline boat motor "half seas over" is likely to be as distressing as a bob-tail flush that does not fill. For while the engine, if it works all right, may pull out a winner, the chances are quite as good that the excessive power of the explosive will blow it to smithereens, and if this does not happen, the after effect of the acid on the engine cylinder is about like that of alcoholic stimulants on the human or equine system. It certainly damages the constitution of the whole machine because it will pit the surface of the cylinder and piston and will rack the joints and bearings badly.

If high stakes are to be won on a race, it might be worth while to take the damage to the engine and the chances of wrecking it for the sake of the possible gain but for ordinary, every-day jogging along, a sober engine is better than a drunken one.

Fast and Lofty Traveling

Such expressions as "Isn't he a bird?" "He's a high flyer" and the like are losing their malodorous significance in these days of flying machine meets and rapidly smashed records. No sooner are we used to the idea that man can fly at all, than we have to absorb the idea that he can fly faster and higher than the eagle and kite that we have been taught to think of as doing things to which man might not aspire. A thousand feet above the earth and speeds of 40 miles an hour seemed big for the first year of real flying, but now come the records of 4,000 ft. in the air and 55 miles an hour, cross country and over the sea trips, and the end is not yet.

Of course it is nothing but a sport; so was the auto a few years ago. Even as a sport, those who have been fortunate enough to try it say that there is nothing to compare with the exhilaration of it, and high speed in the air will have nothing like as great danger compared to low speed as is the case in the auto. With machines costing $1,200 and reasonable control, why isn't a trip from New York to Philadelphia over a right of way that is free to all and requires no expense for upkeep a much more reasonable proposition than an auto trip? Auto cab service between cities a hundred miles or less apart seems not so much like a remote possibility as like a probable good investment of the near future. In fact some of the "joy riding" at the recent Los Angeles meet was free cab service to those fortunate enough to participate; and the fancy flying there made the little known pastime seem as safe as riding a bicycle.

T. P. A. MEETING

On Jan. 10 was held an open meeting of the Technical Publicity Association of New York. Secretary H. H. Kress presided and announced at the outset the growing condition of the association and the enormous work to be taken up.

C. R. Lippmann, advertising manager Genuine Bangor Slate Co., Easton, Pa., suggested methods whereby members of the T. P. A. collectively could gather a vast amount of advertising and merchandising information. He also suggested the desirability of interesting the heads of firms more actively in advertising and its fullest importance, that employers, sales managers and salesmen did not take proper interest in advertising. He suggested an "Employers' evening," when the members of the T. P. A. bring the managing officers of their sales departments.

Geo. W. Wharton disclosed some interesting information of the press bureaus and press agents in influencing public opinion, and H. Tipper told of a curious advertising situation in merchandising.

H. M. Horr spoke about "Direct Mail Advertising" and the benefits of "circularizing" by form letters. He pointed out that by far the greatest percentage of form letters sent out is surprisingly uneffective and proved his claim with an exhibit of some of the worst. Some of these added greatly to the hilarity of the occasion. Mr. Horr also stated that direct advertising has no conflict with trade paper advertising, but deserved a place in almost every well regulated advertising campaign.

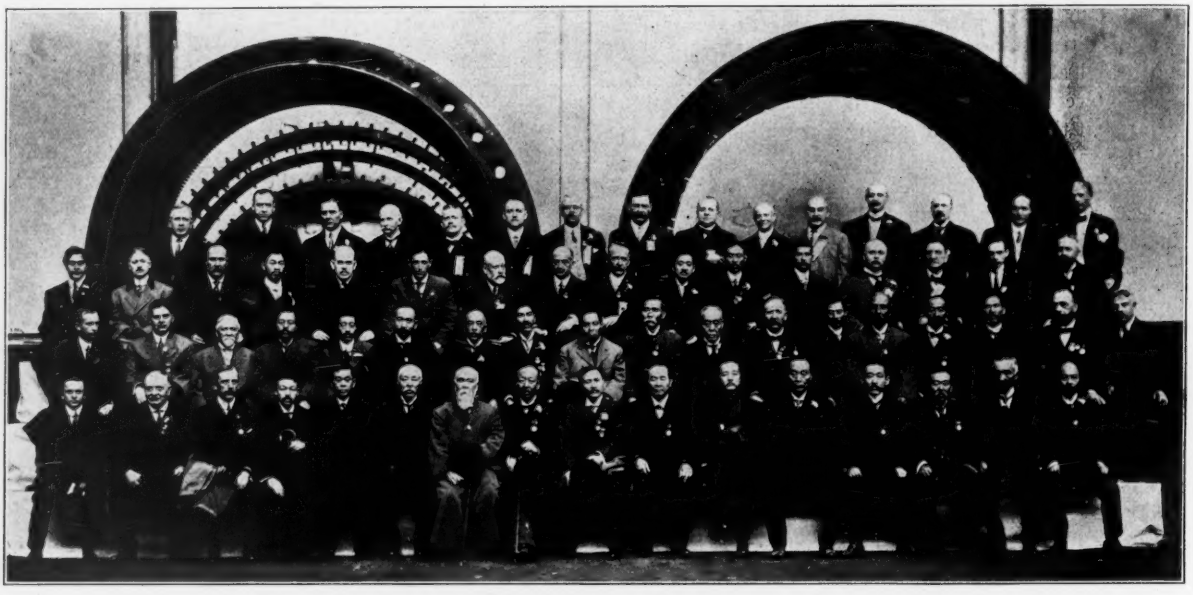
Barrett Smith, Advertising Manager of Stone & Webster Engineering Corporation, Boston, then registered a few protests against the unprofessional things in advertising practice as seen by one of professional training in another field; talking "straight from the shoulder" about some sore spots and offering suggestions for the solution of some defects.

Subsequently an energetic discussion on the uniform advertising contract proposed by the committee held the meeting till quite late. The proposed contract will again come up for final action at the next meeting Feb. 10.

The February meeting will be held on the 10th at the National Arts Club.

DISTINGUISHED VISITORS TO THE WESTINGHOUSE WORKS

Last fall a delegation of 39 honorary commercial commissioners from Japan, who were taking a trip through the United States, visited Pittsburg for 2 days and inspected the large plants of the Carnegie Steel Co., Westinghouse Electric & Mfg. Co., and the Westinghouse Air Brake Co. This delegation was shown through the works under the guidance of Messrs. E. M. Herr and W. M. McFarland, of the Westinghouse Electric & Mfg. Co., H. T. Herr of the Westinghouse Machine Co., and John F. Miller of the Westinghouse Air Brake Co. They saw under test the large marine steam turbine with reducing gear, several large electric locomotives, including those with side rods for the Pennsylvania Railroad, and were afterward entertained at dinner by the Westinghouse Companies. The picture herewith shows the delegation taken at the Westinghouse shops with their guides. The importance of the delegation can be seen from the positions held by some of the members. Baron E. Shibusawa, chairman of the commission, is president of the First Bank of Japan; Buei Nakano is the president of the Tokio Stock Exchange and Chamber of Commerce; Kahei Otani is director of the Yokohama Water Works and the Yokohama Electric Wire Co. and president of the Yokohama Bank, and other members of the commission held like important positions in their own country.



JAPANESE COMMERCIAL EMBASSY AT THE WESTINGHOUSE WORKS

JOHN A. J. SHULTZ

What seemed at first a minor accident, resulted in the loss to St. Louis of an honored citizen and to the power industry of a most valued member of the craft. While crossing the street, John A. J. Shultz, president of the Shultz Belting Co., sustained a sprain in the foot, which resulted in complications and finally caused death, which came suddenly when he seemed well on the way to recovery.

Mr. Shultz was a native of Maryland, born at Grantsville in 1837. He was in the business of tanning there, but moved to St. Louis in 1864 to engage in handling hides to which was later added a commission department. Afterward the firm of Ford & Shultz, tanners, was formed and on the death of Mr. Ford the Schultz Belting Co. was organized.

In social organizations and among his fellow men Mr. Shultz was held in high esteem; he was a charter member of the Missouri Society, Sons of the Revolution, a 32nd degree Scottish Rite Mason, and was twice elected president of the Missouri Manufacturers' Association, which position he held at the time of his death.

NEWS NOTES

NEWBURYPORT, MASS., Association of Stationary Engineers had a particularly pleasant meeting at their 14th anniversary which was presided over by Past President Chas. R. Hodgkins, of Amesbury. After the usual gastronomic preliminaries the speaking program was taken up. The topic under discussion was Education for Stationary Engineers, and the speakers were, C. H. Carney, State Deputy of Boston; P. E. Terrill, State President; T. J. Kelsey, Past National President; James Summers, State Secretary; P. H. Hogan, Past National President; George Finch, Vice State President; E. C. Draper, and O. A. Draper, of Haverhill.

Letters were read from Charles E. Winther, Boston; James Perkins, Lynn; George W. Adams, New York; John W. Lane, Chicago, who were unable to attend.

ON JAN. 13 THE PONTIAC, Mich., Association of Stationary Engineers was entertained by the Michigan Steam Motor Co. of that city and in turn entertained a large number of guests from out of town as well as in town. The entertainment took the form of a banquet, prior to which the entire company inspected a new truck of the twin quadruple compound condensing type having 20 hp. motors which run at 900 revolutions a minute and have an overload capacity equal to the rating, i. e., the motors can develop temporarily 40 hp. The engine has no flywheel and consists of 2 nests of 4 cylinders each at right angles to each other. It cannot, therefore, be on dead center at any point. The 4 pistons of each

nest operate by a single connecting rod driving a part of the shaft to which is attached a balance weight. The steam valve is of hollow piston type, operated by a spiral eccentric sleeve which revolves on the shaft, a method of control which is simple but permit of instant and easy reversal of the engine.

Dimensions of the engine will be of interest. It develops 24 hp. and is 34 by 22 by 15 in. over all. The cylinders are 2, 2¾, 3½ and 5½ in. on each side, connected quadruple expansion with valve travel of 5/8-in. and piston stroke 3½ in., steam being cut off at 3⅞ in. stroke. The boiler is 28 by 40 in. and carries steam pressure at 350 lb. with steam superheated. To deliver a uniform power of 50 horse for an hour requires 3½ gal. of kerosene oil and 16 gal. of water, and the tests are stated to show 26¾ per cent of the heat units in the fuel utilized on the driving shaft of the engine.

ON THE 7TH OF JANUARY was held at Howe Hall in Boston the annual ladies' night and public installation of officers of the Engineers' Blue Room Club of that city. After the entertainment dancing was in order and the evening was one of enjoyment and good fellowship. The arrangements were in charge of Messrs. Harry H. Ashton, of the Ashton Valve Co., Richard K. Neptune and Harry H. Atkinson.

FRIENDS OF LEROY M. HARVEY, sales manager of the Milwaukee district office, Allis-Chalmers Co., were grieved to learn of his death on the 19th of January. Mr. Harvey had been in poor health for 5 months and recently went to Augusta, Ga., in an effort to recover his usual vigor, but the attempt was unsuccessful.

He was born in Oak Park, Ill., 37 years ago and after completing public school work entered the University of Michigan, graduating in 1898 as an electrical engineer. After graduation he entered the works of the Westinghouse Electric Co. and from there, after a year of experience, took up experimental work with Siemens & Halske Co. in Chicago. He was for some time in the Chicago sales office of the Northern Electric Mfg. Co. and 6 years ago went with the Allis-Chalmers Co. in its sales department. For 3 years he has been manager of the Milwaukee district office.

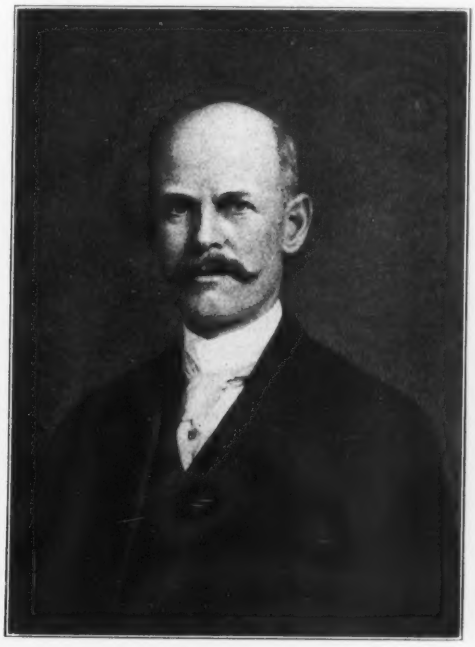
Mr. Harvey was a member of the Milwaukee Club and the Milwaukee Country Club, and in 1903 was married to Miss Julia Stewart, who survives him.

ON ACCOUNT OF INCREASING BUSINESS in hydraulic tools and turbine pumps, the Watson-Stillman Co. has made several additions to its sales department. Edwin Stillman is assisting in looking after customers in New York State, and Frank C. Clark has been put in charge of all southern railroad business. Business in the Orient, which now demands more direct representation than has formerly been given, will be in the hands of F. W. Horn, of Yokohama, Japan.

OF INTEREST TO THOSE ENGINEERS whose boilers are giving them trouble will be a new company organized in New York for the manufacture of boiler compound. This is Green, Hook & Co., with main office in the Hudson Terminal Building, New York, and branch offices in the important cities throughout the country. The officers of the new company are: Stanley K. Green, formerly of Geo. W. Lord Co., sales manager; John Barnes, lately with the Bird-Archer Co., in charge of the Jersey City laboratory, assisted by his son, Geo. W. Barnes, who has also been in the factory of the Bird-Archer Co.; Chester W. Ahlum, recently chief chemist with the Geo. W. Lord Co., will be consulting engineer. Different branch offices will be in charge of the following men: New York, H. E. Chapman, lately the chief inspector of the Bird-Archer Co.; Geo. W. Worth, recently boiler inspector for New York City; Geo. W. Laughton, recently with the Crandall Packing Co., and W. B. Pierce; Boston: Sidney B. Phillips, recently Boston manager for Bird-Archer Co.; Baltimore: W. S. Fechter, lately Baltimore manager of the Bird-Archer Co.; Norfolk: Capt. E. V. White; Havana, Cuba: J. E. Hernandez; the Southern states, E. Q. Smith, recently sales manager of the Bird-Archer Co. for the same territory.

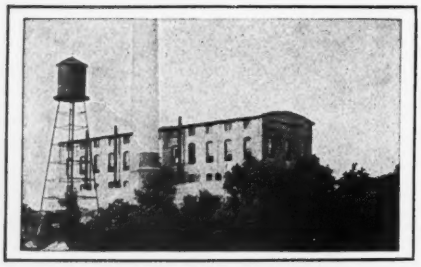
Advertising for the Green, Hook Co. will be handled by A. E. Michel, late publicity manager for the Bird-Archer Co.

DR. EDWARD G. ACHESON of Niagara Falls, N. Y., whose work in discovering carborundum and artificial graphite are well known, was decorated at the recent meeting of the Society of Chemical Industry with the Perkin medal, the highest honor that can be awarded a worker in the chemical field. This medal was founded in honor of Geo. Perkin, an English chemist, who worked



out the process for making aniline dyes and is awarded by the highest authority on industrial chemistry only to those who have made exceptionally noteworthy contributions to progress in the art. This recognition of Dr. Acheson's ability of the importance of his work and of the value of the products that he has discovered is therefore peculiarly fitting and gratifying.

W. J. BEST, for the past 3 yr. Chicago sales manager and engineer for the Buckeye Engine Co., has taken a position with the Wheeler Condenser & Engineering Co., Carteret, N. J., with the title of treasurer. Before his connection with the Buckeye Engine Co., Mr. Best was for 5 yr. sales engineer with The Green Fuel Economizer Co., in its Chicago office, having previously been erecting engineer for E. F. Williams, in which capacity he put in many large steam power stations, such as those of the St. Joseph (Mo.) Railway & Light Co., the Imperial Electric Light, of St. Louis, Mo., and the New Orleans Edison Co. For 5 yr. previous to this he was eastern engineer, located at New York, for the Buckeye Engine Co. Besides acting as treasurer for the Wheeler Condenser & Engineering Co., Mr. Best will also have charge of part of the sales and engineering work.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

WHY THAT ENGINEER HAS PURCHASING POWER

By Zeno W. Putnam

MORE than one serious boiler wreck has been averted because the dangerous pressure first leaked through the engineer's temper, instead of through the crown sheets.

To many of the internal strains incident to any manufacturing concern, the fearless old kicker—usually some high-priced man who is hard to replace, and who would a little rather speak his mind to the head of the concern than to the office boy—is the most valuable safety-valve in the whole place. He keeps his own part of the business free from serious defects, because of the protests he is sure to file if things go contrary to his liking.

If the boiler is unsafe, he does not report meekly that it needs a little fixing. He simply says that it must be fixed, or there'll be all kinds of trouble. Or, if a shaft is out of line, his morning greeting may be: "If you fellows think I am keeping up steam for the fun of seeing the engine pull, find out different; then get that shaft into place, or else come over and chase the pulleys with a wabble-gear."

Sometimes He Voices the Sentiment of the Entire Shop

That keeps the machinery in good repair, but there are other things. Some day, presuming upon long acquaintance and his well-known interest in the business, he is likely to sound a warning note like this: "If you don't want the men to strike, you had better come down with a little up-to-date machinery, or else cut off their supply of reading matter. A man isn't going to do the drudgery of a pair of gears when he knows just where the gears ought to go in."

That may seem like unforgivable impertinence, but it isn't. It's only a warning pop of the safety valve, and one that you will do right well to make a note of. No one else is quite as quick to appreciate the hard and useless work well selected machinery will save the men, as the men who would be benefited by the machines.

Perhaps the growl is about a leaky roof that you know nothing about, until some day, just after this cranky old knight of the engine room has pinched his finger, a cold drop happens to smite his marble top, and then rolls gently down the back of his neck.

He will be in the office before that drop strikes the space between his shoulder blades, and before it reaches the belt line, will let you know about every leak in the building. Perhaps you would be madder than he is under similar conditions—if you could.

He Reads, and Is Influenced by, the Papers in His Field

Some morning he may come to you with light in his eye and war in his voice, the latest engineering journal in his hand. That means that he has been reading to a purpose, and applying what he reads to his own surroundings. He has found some machine described which his practical eye tells him is needed in the plant.

He has seen the weak point of the equipment day after day, and has, as likely as not, been on the lookout for the remedy. Rest assured that he has studied the advertisements faithfully and has found pretty nearly what is needed before putting the matter up to "the boss." More than likely he is prepared to tell how much power and how much hand work the machine would save, as well as how much of a loss there is in running the old way. It is worth looking into carefully.

He Is a Collector and Student of Catalogs

There is a case of well-worn catalogs in some corner of the engineer's dominions, where, if you look, you may find the one that salesman left, that was tossed promptly into the waste basket and afterwards regretted. He rescued it, and if you want to know how much real merit there is in that machine, just go and ask him.

He found out the weak point while re-equipping the whole place with new machinery, in fancy, as he has done a score of times. To do this, he has had to gather in many other catalogs. He has been watching the advertisements, and gathered in the catalogs he needed to fit the place up with an ideal equipment; now he is prepared to give out the results of his investigations.

He has the keenest interest in the proper working of the plant, the very force of his expressions proves it—and withal, the keen appreciation of the skilled machinist, minus the worries that beset the business man, he is prepared at a moment's notice to advise in the replacing of any part or any one of the machines.

He Knows Most About the Machines Most Advertised

Of course, his judgment may not be infallible, for he is limited in his researches to that machinery which is advertised, or which he sees exploited in the current engineering journals. With these he is an authority.

If anything baffles him at first, his fighting blood is up until he masters it. There may be something better on the market for the place. If it isn't advertised, he probably has no catalog of it, and so pins his faith to the machine about which he knows. That has the place of honor in the equipment of his fancy, and will be what he will put up to "the boss" when his mechanical dreams materialize. A skilful salesman may sidetrack his cherished plans, but woe be unto that same salesman and the house he represents if his machine does not make good. He may be able to deceive the whole upper push of the establishment, but he can never deceive a hostile engineer.

After all, the main thing with the engineer is to get the best there is. If he insists upon occasional replacements, it is because his observation has told him that they are needed, either through wear or be-

cause the times have gone ahead another cycle, and the equipment of his fancy has gone too far in advance of that in his physical charge to work in harmony with it.

The Engineer a Power in Other Plants

Let us honor then, the cranky engineer. Remember that just as the engineer is a power in your plant, just so is his influence felt in other establishments, and if you make anything that is used in his department, or in those with which he has more or less to do, it will pay, and pay well, to build up in his mind, through advertisements in his trade journals, circulars and personal calls by salesmen, a prejudice favorable to your goods.

The product that represents his judgment as to what is needed—the one about which he has been educated—will not only be given every chance to demonstrate its fitness for the work, but will actually be forced to do so, if that is possible, for the engineer becomes a warm partizan for the thing that has been purchased by him or on his recommendation.

If we are salesmen for something used by the engineer, let us be thankful to him for his firm insistence on keeping his equipment up-to-date, for his quick appreciation of all that is good in ours, of all that is antiquated in his own, and for the vigorous language in which he tells the story to his chief. Then let us be thankful to our publicity man, whose liberal advertising and skilfully prepared catalogs installed our line of machinery into the equipment of the engineer's imagination, and so prepared him to speak the word that gave to us a contract we might not, against his will, have had the good fortune to receive.

J. F. CANADY CO. has removed its office from 2 Rector St. to 39 Cortlandt St., New York.

THE CANADY SYSTEM OF MECHANICAL DRAFT

The Canady system of mechanical draft is adaptable to furnaces of any type of steam generating boilers, burning any kind of fuel, and is of especial advantage where it is desired to burn the smaller sizes of coal.

The main feature of this system, and to which it owes its success, is the Climax combustion controller, an ingenious device that automatically regulates the air supply to the furnace. By referring to the illustrations and description, it will be noted that the air supply is entirely regulated by the changing pressures in the furnace due to the varying positions of the flue or stack damper, thickness and condition of fuel bed, etc.

The system can be adjusted to maintain any desired vacuum or pull over the fire from 0.01 in. water upwards. In addition to the close regulation, the prevention of blowing out of gases through open fire doors or apertures in the boiler setting, overcomes the objectionable features of many forced draft installations.

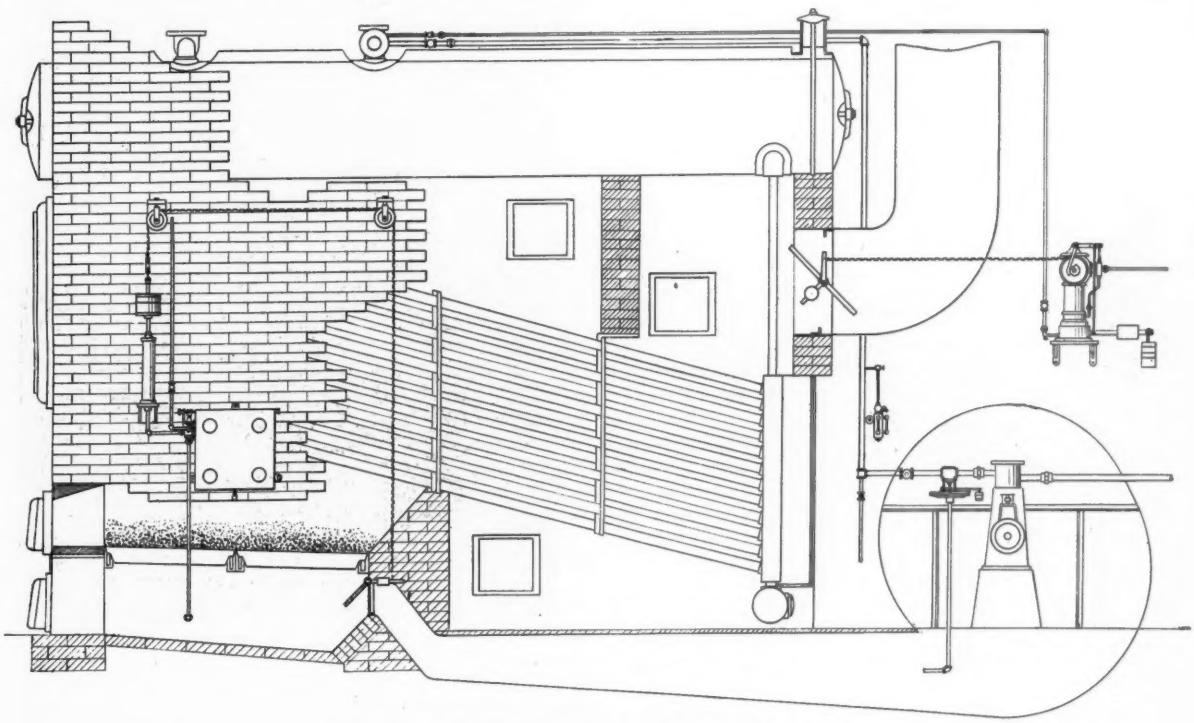


FIG. I.—CANADY SYSTEM OF MECHANICAL DRAFT

The mechanical apparatus for the complete installation consists of a fan, a damper regulator and combustion controllers. The fan is either steam or electrically driven, regulated automatically to supply and maintain a uniform pressure of air in the ducts leading to the ash pits of each furnace.

The standard damper regulator controls the position of the uptake damper, according to the variations of the steam pressure.

A Climax combustion controller is placed on each furnace, for regulating the supply of air to the fuel as called upon by the changes of pressures above the fire, due to the changing of position of the uptake damper.

The diaphragm C in the controller box is in direct communication with the furnace gases A, by means of tube B.

When the steam pressure drops, the damper regulator opens the uptake damper, causing a partial vacuum in the combustion chamber. The controller diaphragm, impelled by such vacuum, immediately swings inward to E, and in so doing operates the motor G that controls the air supply damper H and admits sufficient air to the fire. When the required steam pressure is regained, the uptake damper closes, reversing the controllers action, and shuts off the air supply.

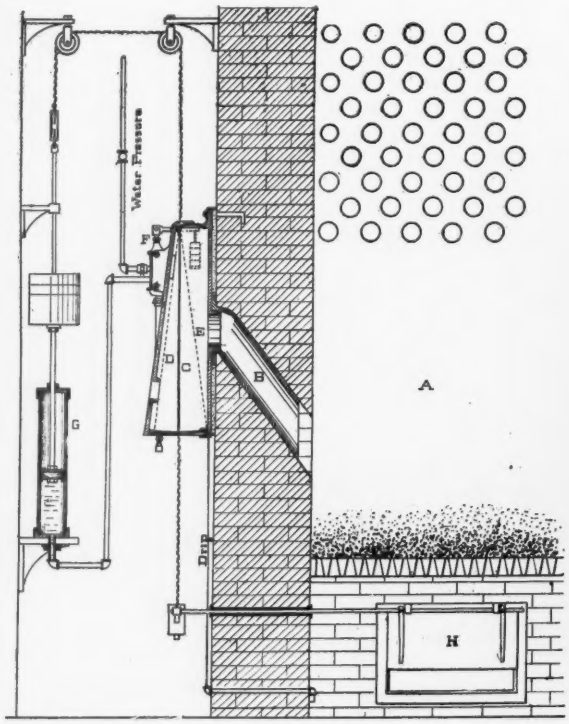


FIG. 2.—SECTIONAL VIEW OF CLIMAX COMBUSTION CONTROLLER

Whatever position the uptake damper may take, the controller places the air supply damper in a suitable position to hold the gases over the fire in tension at the exact vacuum desired.

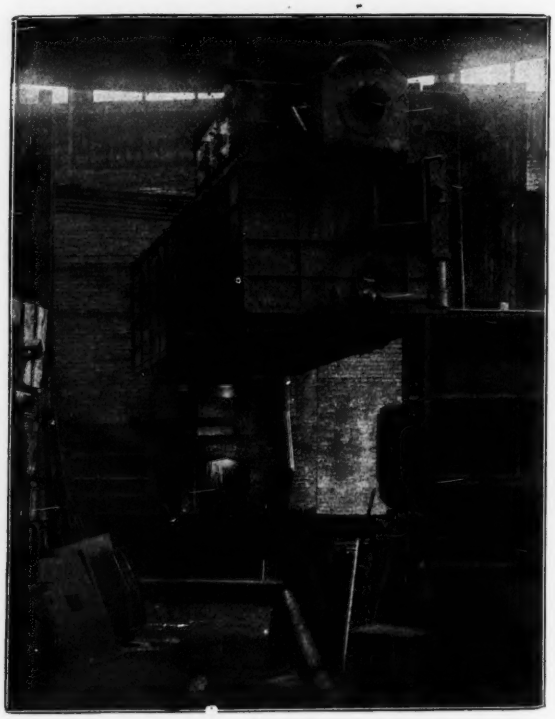
SOFTENING MAKE-UP WATER IN EXHAUST STEAM HEATING SYSTEMS

Where exhaust steam is used for heating and drying it has become quite universal to utilize the returns as boiler feed. In early practice there was some objection to this on account of the cylinder oil from the engine present in the condensed returns, but certain types of oil separators have now been so far perfected that this trouble has been eliminated, and many large plants, including some of the most notable office-building and hotels in our large cities are run on this system winter after winter without the least evidence of oil showing up in the boilers.

A certain amount of raw water must, however, be added to make up that which is lost by leakage, by escape of steam through back pressure valves and in various other ways. This raw water will contain more or less scale-forming matter, according to the nature of the supply available, and it is found that scale slowly deposited from a small percentage of make-up water is much harder. Because of this and the fact that it is often overlooked, it is more dangerous to boilers than the more porous and rapidly formed scale that would be deposited, if the boiler supply were made up entirely of raw water.

At the same time, the installation of a complicated purifying system to treat this comparatively small amount of water would hardly be justified, especially as it requires as much expert chemical knowledge to treat a small volume of water as a large one.

Another way in which condensed returns may become objectionable as boiler feed is through the admixture of air and gases. There is, it is true, a widely



MAKE-UP WATER SOFTENING APPARATUS

spread superstition among engineers that boiler feed water, such as surface condensation or other distilled water, can be too pure for the good of the boiler, that is, that it will cause corrosion.

This is, however, a fallacy, as shown by repeated and thorough investigations by chemists, both in this country and in Germany, who have demonstrated that chemically pure water is entirely inert and that corrosion is always conditional upon the presence of dissolved gases and salts in the water, and more particularly the presence of oxygen, that is, of air. Aeration of boiler feed water may take place in several ways, one of the most common of which is through the use of outside packed plunger pumps, which often draw in and mix with the water quite a volume of air.

As is well known, heating the water drives off contained gases. The breaking up of bicarbonate of lime by heat also sets free carbon dioxide, the remaining normal carbonate being precipitated as a sludge. It is for this reason that open feed-water heaters are often used as purifiers.

Many waters contain other solids in solution, the most common of which are the sulphates of lime and

magnesia. Fortunately, however, it is possible to transform the sulphates and also the nitrates, chlorides and acids by a single and inexpensive reagent, namely, soda ash, and the reaction of soda ash with sulphates or other salts takes place more rapidly and more completely in hot water than in cold. Conversely, it has been found that the presence of soda ash in solution encourages the precipitation of carbonate by heat.

The apparatus shown in the accompanying view, furnished by the Harrison Safety Boiler Works, 3144 North 17th St., Philadelphia, Pa., has been especially designed for use in connection with exhaust steam heating and drying plants where the make-up water requires softening. It is so arranged that the reagent is fed continuously in proportion to the inflow of make-up water, and suitable provision is made for the removal of the resulting precipitate from the water by deposit and filtration. A special feature is a bypass which comes into play automatically in case the filter should be neglected and allowed to clog, thus insuring a supply of hot softened water to the boiler feed pumps at all times.

The makers guarantee for this apparatus that where it is operated in accordance with their instructions, hard scale which cannot be washed out by means of water from a hose will not form in the boilers, and that the boilers will be entirely protected from corrosion. They also guarantee that water heated by exhaust steam that has been passed through the oil separator attached to the apparatus, or water condensed from the steam itself, will be entirely suitable for boiler feeding and other purposes.

In the apparatus here shown, the returns and treated raw water are mingled together in the sedimentation chamber and the whole volume is passed through the filter, but where the percentage of returns is large it may be advisable to give over the entire deposit and filtering capacity to the make-up water alone and to pass the pure condensed returns, after reheating, directly to the pump supply chamber. This gives better results than if the 2 water supplies are mingled before treatment.

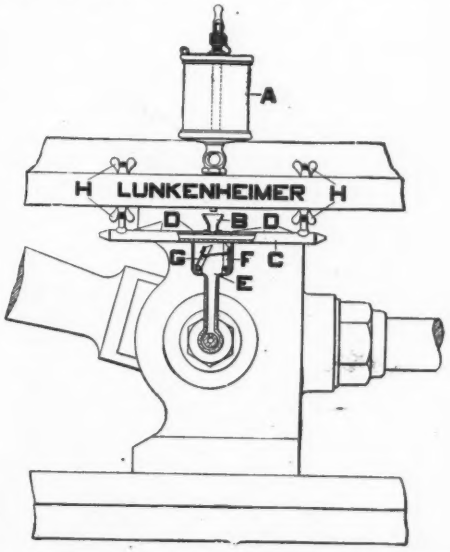
This apparatus is also applicable in the case of surface condensing steam-power plants where the condensate is utilized as boiler feed, in which case there is the large volume of condensate to be heated and a comparatively small volume of supplementary make-up water to be heated and softened. The apparatus can then be so arranged that the exhaust steam will first come in contact with the make-up water, insuring full temperature for the chemical reaction, before heating the vacuum pump discharge. As will be apparent, this apparatus saves a large part of the cost of separate feed water heater and water purifying system and makes it possible to purify the small amount of raw water at a merely nominal cost. The driving off of air and gases from the feed water reduces to a certain extent the amount of gases to be dealt with by the vacuum pump, while the elimination of scale-forming matter from the water should obviate the gathering of scale upon and erosion of turbine blades.

CROSS-HEAD PIN OILING

One never goes into a power house and sees a new, nicely enameled engine, oiled by the ordinary system of sight oil cups, covered with oil and dirt but what the question arises: Has the ingenuity of man failed to contrive a device which will save and utilize this waste oil to good purpose? This result has been accomplished by Messrs. Harvey and Wheaton, practical engineers of long experience, who have designed and patented a device known as the Lunkenheimer H-W-Cross-Head Pin Oiler, which is now being manufactured by the Lunkenheimer Co.

The operation of this device, which is adaptable to any horizontal engine, will be understood from the illustration. The oil from the cup A is fed by gravity into the funnel B on the oil tube C. It then overflows through the small holes D in the top of the tube, enveloping the outside of the tube with a film of oil. The wiper cup E being rigidly attached to the pin, travels with it directly under the tube. As the piston rod travels to the left the tongue F scrapes the oil off the bottom of the tube.

A reversed motion of the piston rod throws the tongue F down, but as the tongues F and G are directly connected, E is thereby thrown in a vertical position, and in turn scrapes the oil off the tube. This action is repeated upon every forward and backward motion of the piston. The oil dropping into the wiper cup forms a column in the shank of the cup, and as the shank is considerably higher than the oil outlet in the pin, the oil is fed under pressure, thus insuring a positive feed.



LUNKENHEIMER H-W CROSS-HEAD PIN OILER

This device is perfectly noiseless when in operation and can be adjusted while the engine is running by turning the thumb nuts, H.

THE RETURN CALL

Maybe you don't get a single order in all your calls. What's to be done? Well! are you sure that you showed all the advantages of your goods or all the styles to everyone who ought to be interested. Isn't there some one man or several whom you ought, for their own good, to show how they can save money on a special tool? It's a good chance for a return call, and, remember, a chance to save money always interests everyone.

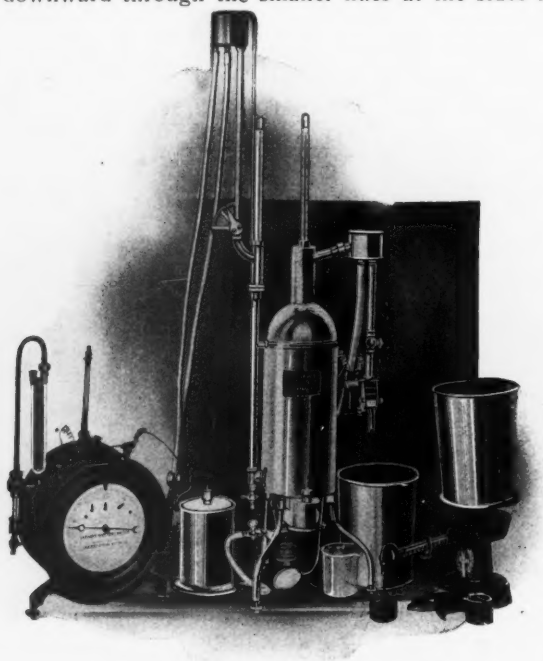
Every article has 2 vital points involved in the sale—what it will do?—what will it cost? The last named should be the buyer's last consideration and will be if the merits of the goods are presented in the right light. Make the saving to him strongly evident and the return call will be welcomed and profitable.

Money saving goods are mostly specialties and must show that they make a profit for the buyer; how much they save is more important than how much they cost,

and keeping this fact and the "show me" spirit well in evidence will turn many a return call into a profitable trip.

THE SARGENT AUTOMATIC GAS CALORIMETER

This calorimeter is intended to determine quickly the heat value and amount of foreign matter in gases. It is similar to the Junker calorimeter in action but differs in details of construction. Two views herewith show the cross section of the machine and its arrangement for working. Water is circulated through the body of the calorimeter under constant head maintained by the reservoir E. As the water enters the calorimeter body, the temperature is taken by thermometer C, and as it leaves temperature is taken by thermometer D. The gas is burned in the central flue, the products of combustion passing to the top and then downward through the smaller flues at the sides and



THE SARGENT GAS CALORIMETER

out at the bottom, where a damper regulates the velocity and the thermometer B gives the temperature of the exhaust gases.

The water as it leaves the calorimeter is discharged into an automatic bucket, H, which tips to spill the water when a certain weight has entered.

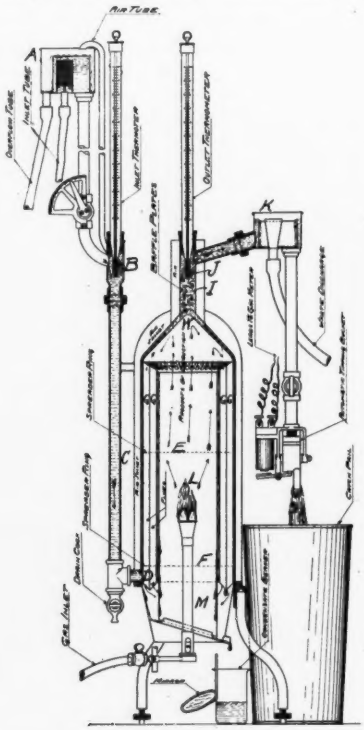
The special features of this calorimeter are that the water enters and leaves at the top so that thermometers can be placed near each other and conveniently read. The cold entering water is on the outside of the warm discharge water, thus absorbing any heat which might be radiated. The Bunsen burner is protected from draft on all sides, thus preventing irregular combustion. Outlet water is weighed, thus eliminating errors of measurement caused by variation of temperature. The water weighing is automatic, the receptacle being changed when 0.1 cu. ft. has passed, so that the operator has time to determine and record the B. t. u. for every 0.1 ft. burned.

Gas pressure is controlled by micrometer adjustment between the gas meter and the calorimeter, so that a constant flame is insured.

THE MANZEL FORCE AND SIGHT FEED OIL PUMP

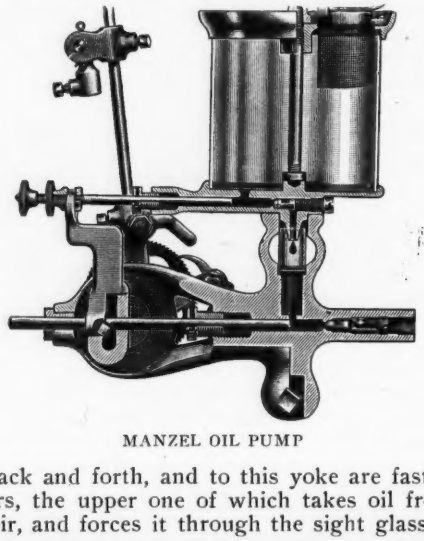
The Manzel Oil Pump, sectional view of which is shown herewith, is distinguished by simplicity of design, easy feed regulation, simple construction, the provision of a hand attachment for special operation, and a down sight feed which does not clog up or get dirty.

The study of the sectional view will show that the ratchet, which is operated by connection to the piston



SECTION OF SARGENT CALORIMETER

or some other moving part of the engine, drives a ratchet wheel, on the axle of which is carried an eccentric. This eccentric driving a Scotch yoke, carries the



MANZEL OIL PUMP

yoke back and forth, and to this yoke are fastened 2 plungers, the upper one of which takes oil from the reservoir, and forces it through the sight glass, while

the lower one takes it from the delivery of the sight glass, and forces it into the steam cylinder. The amount of oil supplied at each stroke is adjusted by no possibility of any oil remaining in the sight glass. The glass cannot, therefore, fill up or become clogged in any way.

It is evident that, after the pump is once adjusted to feed a given quantity of oil, it requires no further attention, and this feed can be readily adjusted either while the pump is running or before it starts. If a pump has more than 1 feed, the speed is regulated independently on each one so that different rates of feed can be supplied into different cylinders or the different bearings on an engine.

The sight feed is arranged without liquid of any kind in the glass and there is no pressure in the glass at any time, so that there is no danger of breakage.

In construction the greatest precautions are taken to have the pump durable and satisfactory. Ratchet wheels are of drop forged tool steel with milled cut teeth. Pawls are also of tool steel, and both the ratchet wheels and pawls are case hardened after being machined. Bearings are wide with large wearing surfaces and all working parts are outside where they are easily accessible. Finish on all pumps is in heavy nickel plate, which gives handsome appearance and durability.

For operation before starting up the engine, or in case more oil is needed for a moment, a hand attachment is provided on the ratchet wheel which permits of feeding at any rate desired. The use of this hand attachment does not in any way disturb the feed adjustment and, when hand feeding is stopped, the ratchet feed will go on just the same as before.

These pumps are made by Manzel Bros., of Buffalo, N. Y.

FILTERING WATER

The Sucro system originated in Germany and recently introduced into this country is devised for the purpose of filtering any liquid containing organic impurities for any purpose whatever.

In this system the filtering medium is a cell consisting of a frame of any suitable size or shape, surrounded by a flexible filtering material. A small pipe introduced into the upper part of the cell acts as an air vent, the filtering material having been produced by fusing chemically pure asbestos cloth and a porcelain-like substance into a homogeneous mass which is non-breakable and heat and frost proof. Each square inch of filtering material contains approximately 195,000 pores.

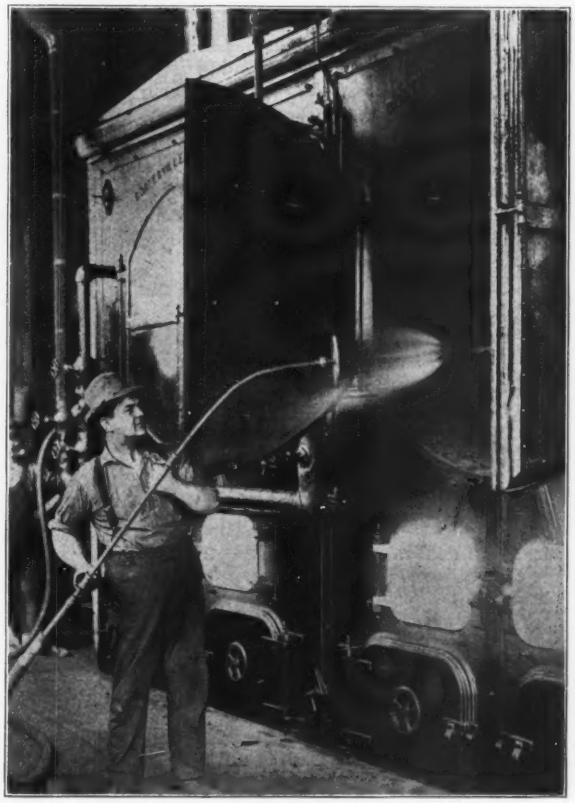
Most of the liquid to be filtered passes through the cell horizontally, so that the large part of the impurities immediately sink to the bottom of the tank containing the cell. The liquid also passes from the inside of the cell to the outside, which effectually prevents clogging of the pores. The compact form of the cell permits of its ready cleaning and sterilization and the number of cells used depends upon the amount of liquid to be filtered. For usual household and office purposes a single cell is required. The filter for a factory or power plant is the same in operation only that it uses a larger number of cells.

The average output of the Sucro system is about 3 gal. an hour per square foot of filtering area, but the perpendicular position of the filtering cells makes a large filtering area possible within a small space. The device is made by the Sucro Filtering Co., 42 Broadway, New York.

THE VACUUM TUBE CLEANER

Before being entered in tubes or flues the cleaner is connected to a live steam pipe and all condensation removed, so that only dry steam is used in the cleaning process. In the head of the cleaner is a small counter-bored aperture to aid in relieving the condensation and to aid in agitating the soot as the cleaner head enters the tubes.

The cleaner may be put into the tube 6 to 8 in., or up to the shield which acts as a valve, driving steam the full length of the tube to stir up the soot. As the cleaner is gently withdrawn a vacuum is formed by the



VACUUM TUBE CLEANER READY TO ENTER FLUE

steam flowing out around the shield, thus drawing out soot and scale from the tubes and carrying it to the uptake.

To get good results fires should be burning brightly and freely with damper wide open and draft doors open part way.

As only steam is used there is no cooling and contraction of the tubes in this method of cleaning. Only slight pressure—10 to 15 lb.—is required, and the amount of steam used is small.

This cleaner is made by the Corbett Supply Co., of Trenton, N. J.

JUNE 13-16 has been fixed upon as the dates of the next meeting of the National Gas and Gasoline Engine Trades Association which will be held at Cincinnati, Ohio. The president and secretary of the Association are pushing hard to make this a big success and are promising an interesting list of papers and complete exhibit of engines and accessories and an attractive series of entertainments.

NEW CATALOGS

FROM THE CHAPMAN ENGINEERING CO. of Philadelphia comes an interesting catalogue describing a new type of flanged gaskets made of corrugated copper, case hardened and called the Springtite. This is especially efficient on superheated steam and high pressure work, but is, of course, equally effective on the low pressure work. These gaskets are made up in any desired form, round, eliptical, rectangular, triangular or in any irregular shape.

"IDEAL" AUTOMATIC CONTROLLING VALVES are described in the new catalog of the "Ideal" Automatic Mfg. Co. of New York City.

CATALOG NO. 1 of the Hill Clutch Co. of Cleveland, O., describes the transmission machinery made by that company. This includes shafting, pulleys, rope sheaves, gearing, ring oiling bearings, collar oiling bearings, hangers and clutches. The catalog is entitled A-B-C Engineering.

POWER FROM EXHAUST STEAM is the title of an interesting pamphlet issued by the American Regenerator Co., of Chicago, explaining how heat from the exhaust of an engine may be stored and reused as needed.

HUGHSON STEAM SPECIALTY CO., of Chicago, Ill., in a new catalog gives interesting descriptions and instructive illustration of the Eclipse steam specialties. The novel ideas contained in any of these devices will be found mighty interesting reading. The apparatus described includes exhaust heads, separators, pump governors, safety water columns, blowoff valves, traps, relief and reducing valves.

THE DEARBORN DRUG & CHEMICAL WORKS sends out as a New Year's greeting to its friends a neat card of good wishes and convenient pocket calendars for the year 1910.

INSULATION OF PIPES AND BOILERS is the title of an instructive and interesting booklet issued by the H. W. Johns-Manville Co., of New York City, which gives the history of some examples of successful transmission of steam over long distances when properly insulated. It shows also the different kinds of pipe insulation and which one is best suited for different conditions.

GRAPHITE AS A LUBRICANT is appearing in the 11th edition. It is really a text book treating on this important subject showing what advantages are to be gained in the lubrication of all classes of bearings by the use of graphite, either alone or mixed with oil or grease. It is issued by the Joseph Dixon Crucible Co., of Jersey City, N. J., and will be sent by that company to those who ask for it.

IN A VERY ATTRACTIVE PAMPHLET entitled The Dawn of a New Era in Lighting the General Electric Co. takes up the history of light from the tallow dip to the latest development in artificial lighting, namely, the Tungsten lamp. Following the historical facts, is given the description of the Tungsten lamp, its efficiency, cost of operation and various applications of the lamp in interior lighting.

BULLETIN NO. 4705 devoted to Curtis steam turbines for low pressure and mixed pressure has just been issued by the General Electric Co., and contains considerable information which should be of interest and value to the central station manager. The publication deals with turbines with both horizontal and with vertical shafts.

FOLDER NO. 3884, recently issued by the General Electric Co., is interesting inasmuch as it compares the Tungsten and Carbon sign lamps, and shows plainly the advantages to be derived by the use of the former. It describes also the manner in which an ordinary sign may be transformed into an illuminated sign.

FROM ALBERT SCHADE CO., 56 N. Second St., Philadelphia, comes a convenient and finely gotten up catalog listing a full line of steam specialties, including packings, engine room tools, boiler cleaners, pipe fittings, lubricators, separators, feed water heaters, boiler equipment specialties and valves. It is a book which, in its substantial binding and convenient arrangement, will be found useful by those who receive it in ordering supplies and apparatus as they are needed. Steam users in Eastern Pennsylvania, Southern New Jersey and Delaware will be supplied with copies of this on application.

A PAMPHLET entitled, Arrangement of Engine Cylinders to Produce Uniform Torque has just been issued by the American Engine Co., of Bound Brook, N. J. It contains typical indicator cards taken from the American Ball Angle Compound engine, and also a derived crank effort diagram which shows that this type of engine produces a torque which is nearly as uniform as that given by steam turbines. The booklet also contains a discussion of the crank effort diagram and will be sent free upon application.

A JET CONDENSER giving a vacuum of 28.75 in. mercury which is so designed that a thorough mixture of exhaust steam and cooling water takes place and at the same time the air present is prevented from pocketing and is delivered to the air pump at a minimum temperature, involves numerous interesting departures in condenser design. These features are brought out, and the general theory of jet condenser construction discussed in a reprint of an article, A Radical Improvement in Jet Condensers, which is being distributed by the Wheeler Condenser & Engineering Co., of Carteret, N. J.

A NEW AND GREATLY ENLARGED edition of "Feed Water Filtration" is being distributed gratis by James Beggs & Co., 109 Liberty street, New York. The Blackburn-Smith Feed Water Filter and Grease Extractor is described in detail.

CROSBY RECORDING INSTRUMENTS made by the Crosby Steam Gauge & Valve Company of Boston, are artistically illustrated and interestingly described in a series of illuminated plates contained in a fine portfolio, issued by the company and available on request, to the readers of Practical Engineer. There are 11 pages altogether showing the different kinds of instruments and their uses.

THE LAGONDA MANUFACTURING CO., of Springfield, Ohio, has just published an interesting pamphlet entitled, Scale and the Vacuum. This describes some of the new cleaners especially suited for removing scale from the tubes of surface condensers, ammonia condensers, etc., which have recently been developed. It also contains valuable tables showing the losses in horsepower resulting from the reduction in vacuum, due to the formation of scale in condenser tubes. Copies will be supplied free upon request.

PRESSURE AND VACUUM GAUGES is the title of a handsome and interesting catalog issued by the Schaeffer & Budenberg Mfg. Co., of Brooklyn, N. Y. The cover is embellished with an embossed title and the monogram of the company. Inside are found descriptions and illustrations of the different types of gages for which the company has become noted as an expert in manufacture. These include combined pres-

sure and vacuum gages, pyrometers, illuminated dial gages, ammonia gages, diaphragm gages, test gages, gage board clocks and different arrangements of gage board tablets, mercury vacuum gages, draft gages of various styles, recording gages, both round and cylindrical, and test apparatus for gages of all descriptions.

Of particular interest to engineers will be the draft gages of which there are several forms. There is the dial form, the U tube form with adjustable scale, and the differential draft gage, any one of which is well adapted to the purpose. The dial gage is particularly convenient, as it is simple in construction, is read like a steam gage and measures correctly pressure or draft down to 0.01 in. of water column.

MURRAY CORLISS ENGINES, Murray High Pressure Boilers, and other Murray products are beautifully illustrated and fully described in a handsome catalog just received from the Murray Iron Works, of Burlington, Iowa. This is numbered Catalog No. 65 and is fitted with an embossed cover on which is shown a colored halftone of the Murray Corliss engine. The body of the catalog is printed in 3 colors on a heavy enameled paper, and its appearance is entirely in keeping with the quality and appearance of the Murray products, which is sufficient praise.

TRADE NOTES

THE REAGAN GRATE BAR CO. reports that during the past 4 months it has installed over 100 grates and stoking devices, among which were 22 of these appliances for the Riverside & Dan River Cotton Mills, of Danville, Va.

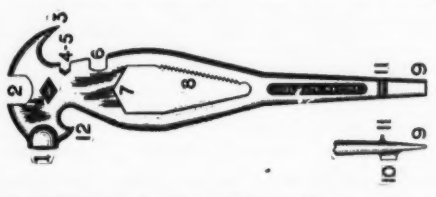
THE REPUBLIC RUBBER CO. of Youngstown, Ohio, has acquired the patent and trade mark rights for Balata belting for this country. Considerable Balata belting has been used in this country for a number of years, all of which has been imported.

The President and General Manager of the English Company are directing the establishment of the new plant at Youngstown, and within a few months, will be prepared to supply this material to manufacturers without the delay and expense incident to importation.

THE AMERICAN GAS AND ELECTRIC CO. has selected Babcock and Wilcox boilers for the new power house at Atlantic City. Each of the 4 500-hp. boilers is to be equipped with a 6-retort Taylor Gravity Underfeed stoker.

AN INDICATOR DIAGRAM from the "Clermont", which excited so much interest during the Hudson-Fulton Celebration, has been secured by A. C. Lippincott, Newark, N. J. Realizing that many engineers would like to get a photo copy of this diagram for their collection, he will send one to any engineer enclosing the names of 3 engineer friends, with correct addresses.

CONVENIENCE, SERVICE AND WEAR are combined in the Williams "Vulcan" Auto tool, made



by J. H. Williams & Co., of Brooklyn, N. Y. These tools are drop-forged from carefully selected steel, milled and ground to correct sizes of openings, tempered, polished and blued. It is a veritable "half-pound tool chest," replacing a dozen ordinary tools. They are packed in canvas bags with button flap and become an unusually adaptable hip-pocket campanion, 8 in. long and ½ lb. in weight.

AFTER THOROUGHLY TRYING OUT over a thousand horsepower of Taylor stokers during the past year at its Pittsfield, Mass., plant, the General Electric Co. has just purchased 2 6-retort Taylor Underfeed Stokers for 2 additional 500-horsepower Stirling boilers, which are to be installed immediately.

THE CONNECTICUT CO. through its engineers, the Westinghouse, Church, Kerr Co., has just purchased 4 6-retort stokers for use in connection with 4 500-horsepower of Hornsby boilers at its power plant in Waterbury, Conn. This is a second order from this company.

DART'S PATENT UNION COUPLING in the reproduced form shown herewith makes a most attractive fob for the engineer's watch. It shows perfectly the bronze to bronze construction which characterizes

the Dart Unions and will be gladly sent by the E. M. Dart Mfg. Co., Providence, R. I., to any engineer who sends 2 cents to pay postage.

THE AVERY SCALE is worked entirely by gravity, requiring no mechanical or electrical power whatever to operate it. The designer of this scale, the Avery Scale Co., is located at North Milwaukee, Wis., and is a branch of the weighing machine manufacturers, Messrs. W. & T. Avery, Ltd., Birmingham, England, who have been in the weighing machine business for nearly 200 yr.; the automatic coal scale has been a special feature with them for the past 25 yr. It was owing to their success with this type of scale in Europe that they decided to start an American branch. Several boiler plants have been equipped with this type of scale, and only recently 8 100-lb. sizes were installed at the new power plant of the Capitol Commission at Madison, Wis. The Avery Company manufactures all kinds of automatic weighing machines, and can supply large scales capable of weighing the coal in bulk as it is received at the power station.

THE AMERICAN SHIP WINDLASS CO., manufacturers of the Taylor Gravity-Underfeed Stoker, has sold to the Shore Line Electric Co. 3 7-retort stokers for 3 625-horsepower Hornsby boilers at its power plant, Saybrook, Conn.

FROM THE CASKEY VALVE CO. comes an offer which many of our readers will find interesting. This company, which is located at 99 John St., New York, sends a folder descriptive of Caskey valves for steam and compresed air and also of the Caskey Universal Couplings for pneumatic hose. These have swivel joint and are tight under all pressures, being arranged so that they are packed by the pressure of the air. The Caskey Co. offers to send a sample for trial to any of our readers free of charge if they mention Practical Engineer when writing.

PHOENIX, a journal devoted to belt engineering, is published by the New York Leather Belting Co. and the issue just received contains many interesting points on this large subject.

ON JANUARY 1 THE Virginia Electric Power & Water Co., Virginia, Minn., began the operation of the additional power apparatus which has just been installed by Allis-Chalmers Co. The new apparatus consists of a 375-kw. low-pressure turbine direct connected to a 2,300-volt, 60-cycle, 3-phase alternator. The turbine receives steam at a pressure of 16.5 lb. absolute, and a 28-in. vacuum is maintained by a Tomlinson type C condenser. Provision is made for supplying the steam ordinarily from the exhaust of a reciprocating engine, but in case of necessity high-pressure steam can be supplied direct from the boilers through a reducing valve.

YORK MANUFACTURING CO. of York, Pa., has been having a remarkable success recently in sales. Among a long list reported are the following:

Darling & Sons, Hampton, Va., 8-ton refrigerating plant and 2-ton freezing system. C. & G. L. Pennock, Lansdowne, Pa., 1 8-ton refrigerating plant. Orange County Brewery, Middletown, N. Y., 1 65-ton compression side. F. Fache & Co., League City, Texas, 1 6-ton refrigerating plant. Holler Ice Manufacturing Co., East Chester, N. Y., 1 100-ton compression side, with 30-ton freezing and distilling system, and 2 100-hp. boilers and system. Lebanon Creamery Co., Lebanon, Pa., 1 10-ton refrigerating plant. Illinois Northern Hospital for Insane, Elgin, Ill., 1 30-ton refrigerating plant and 2 1.5-ton ice plant. S. M. Bixby & Co., New York, N. Y., 1 10-ton refrigerating plant. Aurora Artificial Ice Co., Aurora, Neb., 1 12-ton complete ice making plant. Buffalo Distilled Water Ice Co., Buffalo, N. Y., 1 50-ton ice making plant. Ebling Brewing Co., New York, N. Y., 1 250-ton tandem compound refrigerating machine. F. H. Pierson, Poughkeepsie, N. Y., 1 4-ton refrigerating plant. Crystal Ice & Cold Storage Co., Bartlesville, Okla., 1 65-ton compression side. Conklin & Koegel, Patchogue, L. I., N. Y., 1 15-ton ice making plant. Jamaica Consumers Ice Co., Jamaica, L. I., 1 25-ton complete ice making plant.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rate of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—Superintendent of machine works manufacturing steam, power and refrigerating machinery. Address Box 125, Practical Engineer. 2-2

CHIEF ENGINEER wants position as master mechanic or chief engineer in large establishment; high-speed Corliss engines, ice machines and dynamos; thoroughly competent. Address Box 123, Practical Engineer. 1-2

POSITION WANTED—By engineer, strictly sober, 12 years' practical experience with boilers, chain grate stokers, slide valve and Corliss engines, D. C. dynamo, pumps. Own indicator outfit, and am proficient in its use. State salary. Box 124, Practical Engineer. 1-2

Wanted

WANTED—A 100 hp. right-hand Corliss engine. Address Paul O. Moratz, Bloomington, Ill. 2-1

Help Wanted

WANTED—Live salesmen everywhere. Good commission. Write today. E. H. Reiter, Elgin, Illinois. 2-1

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 15 of this issue. 9-tf

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

AGENTS WANTED to represent us in the sale of Cassco Bar and Ring Metallic Packing—a metallic packing which costs about the same as soft packing and will wear from seven to ten years. Can be handled as a side line very acceptably. Some territory still open for steam specialty men to handle the Erwood Positive Duplex Blow-off Valve and the Erwood Reversible Automatic Non-Return Valve. Address Triumph Engineering & Supply Co., 253 La Salle Street, Chicago, Ill. tf

For Sale

FOR SALE—60 steel storage tanks, 6,000 gallons' capacity. Good as new. Double riveted, extra well built. Suitable for storage of oils, waters or liquids of any kind. 100 steam pumps. Get our prices on engines, boilers and electrical machinery. All sizes and kinds. Chicago House Wrecking Co., 35th and Iron Sts., Chicago.

Machinery For Sale.

FOR SALE—ENGINES AND BOILERS—Corliss—Heavy Duty, 18 x 36 Ohio, 24 x 30 Clark, 22 x 48 Allis. Girder Frame, 14 x 30 Bass, 18 x 42 Allis, 22 x 42 Hamilton, 28 x 54 Hamilton Automatic—All sizes, 30 to 400 hp. Send for list. Throttling engines from 10 to 100 hp. Woodworking machinery of all kinds. Cleveland Belting & Machinery Co., 1922 Scranton road, Cleveland, Ohio. 9-tf

Patents and Patent Attorneys

PATENTS—Watson E. Coleman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4-tf

PATENTS—For a Canadian or foreign patent send sketch for free report. Patentability certificate given. Canadian patents taken up for sale if desired. Send ten cents for booklet and inventors' monthly magazine. Ben. B. Pannett, Ottawa, Ontario, near Patent Office. 9-tf

HAVE YOU AN IDEA? If so write for our books: "Why Patents Pay," "What to Invent," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 Illustrations. All mailed free. F. Dietrich & Co., Patent Lawyers and Experts, Oray Block, Washington, D. C. 1-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4-tf

Miscellaneous

DRY BATTERIES renewed by anyone for 10 to 35c per dozen. Good as new. Formula $1. Will send it this week for 35c. Fairmount Tel. Co., Leightons Corners, N. H 2-1

BARGAINS—Alternating and direct current motors, dynamos, all makes, sizes, sold, bought and repaired. Eugene L. Richter Electric Co., No. 1919 S. Columbia Ave., Philadelphia, Pa. 2-1

ENGINEERS—Pack your Corliss valve rods with Ideal Metallic Packing. Three years' guarantee. Price per inch diameter of rod $1.00. Ideal Metallic Packing Co., South Stillwater, Minn. 8-tf

DRY BATTERIES exhausted can be renewed for one cent each. Save one-half battery expense, simple scientific instructions 25 cents. Satisfaction guaranteed. Dirigo Sales Company, Bath, Maine. 2-1

SAVE MONEY—RENEW OLD DRY BATTERIES—Make good as new at very little cost. Full correct instructions only 25c; regular price $1.00. Northern Supply Co., Battery Dept. 4, 3451 N. Hamilton, Chicago. 2-1

FREE, ANY FIRM owning a steam plant, or any engineer in charge of steam plant, that is troubled with scale and has to use boiler compound can get the best indicator and reducing wheel made free. Address Great Lakes Chemical Co., Manitowoc, Wis. 10-tf